Highway Plan Reading Volume I (English Version) 2013 Edition

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Technology Transfer and Training

DOTD Employee Training Manual

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PREFACE

The objective of Highway Plan Reading Volume I is to convey to each student the information necessary to accurately read and interpret the following Highway Plan Reading materials.

- The Construction Contract
- Title Sheets
- Right of Way Map Sheets
- Plan and Profile Sheets
- Cross – Section Sheets
- Typical Sections and Detail Sheets

The design of Highway Plan Reading Volume I takes into account the DOTD and contract personnel whose duties may involve the reading and interpretation of highway plans.

COURSE DESIGN

Highway Plan Reading Volume I is a self-paced instructional study course with information presented in clear, easy to read topics, where each topic adds to the previous one. This method instructs by giving relatively small pieces of information followed by a series of questions.

Writing the answers in the spaces provided, and then comparing them to the answer key not only produces an excellent set of review notes, it reinforces the material, enabling students to retain it for a longer period.
Students are encouraged to immediately correct any mistakes, then, reread the material until they understand it. Additional review questions at the end of each chapter help students assess their understanding of the material.

COURSE DESIGN (*continued)*

Highway Plan Reading Volume I is a six-chapter manual of instruction with two appendices, a glossary of terms, and the answers to the chapter questions. A Plan Book accompanies the manual. Contained within the Plan Book are reduced-size plan sheets taken from actual plan sets used by the Louisiana Department of Transportation and Development. To illustrate certain features, the Plan Book integrates sheets taken from several different plan sets, some of which are modified to enhance this course.

Unless otherwise indicated, all references to plan sheets examine the material found within the Plan Book. To save reproduction costs, the entire set of plans is not included in the Plan Book.

After completing Highway Plan Reading Volume I, students are encouraged to take the course examination, the results of which will indicate how well each has learned to read and interpret plans.

Students are also urged to rework any portions of the course that present difficulty on the exam.

Before starting this course, check to see that a complete set of training materials is available, it should include the following:

- Volume I of the Highway Plan Reading course (this manual)
- An 11” x 17” Plan Book containing reduced size plan sheets for Highway Plan Reading Volumes I & II

  ** Note: The Plan Book is the same for Volume I and II.*

Although not required for this course, the following publications provide additional reference material.

- The latest edition of the Louisiana Standard Specifications for Road and Bridges
- Highway Specifications Workbook
- Roadway Plan Preparation Manual
- Bridge Plan Preparation Manual

CREDITS

This 2013 copy of Highway Plan Reading Volume I is the third edition. It is a revision of the original course developed in 1968, and rewritten in 2002.

John Dean of LSU/LTRC revised this manual with contributions from Karen Cordell, LTRC Construction Materials Training Staff Manager and Cindy Twiner, the LTRC Structured Training Director. Michael Boudreaux, Technology Transfer and Implementation Engineer contributed to editing and review.

CHAPTER 1
THE CONSTRUCTION CONTRACT

INTRODUCTION

The **CONTRACT** covering the construction project is a **written agreement** between Louisiana Department of Transportation and Development and the contractor. It outlines the obligations and responsibilities of each party. The CONTRACT includes many documents, such as plans, specifications, basis of payment, etc.

Throughout the chapter, consecutive **TOPIC** numbers cover information relevant to the Construction Contract. Occasionally, topic numbers reference one another.

Complete each review question, as they will become useful study guide material.

Whether involved as an inspector or designer, becoming familiar with the various parts of the contract ensures correct and accurate construction of the project.

THE CONTRACT

1-1 Listed below are various parts of a contract, with definitions.

- An **Invitation to Bid** is an advertisement soliciting bids for all work and/or materials on a specific project (where bids are required.) The advertisement includes the time and place of bid openings, project location, and the description of work.

- **Plans** are contractual drawings depicting the location, type, dimensions, materials, and other details of the prescribed work. Plans are the most referenced document(s), they are used to inspect what, where and how the contractor builds.

- A **Proposal** is an offer from a bidder to perform the stated work, and furnish the labor and materials at the prices quoted.

1-1 Contract definitions *(continued)*

- **Specifications** are the collection of documents stating all of the provisions and requirements for the performance of prescribed work and specified materials. There are **three** categories regarding specifications.

    1. **Standard Specifications** - A book of specifications for general application and repetitive use.

    2. **Supplemental Specifications** - Additions and revisions to the Standard Specifications.

    3. **Special Provisions** – Additions and revisions to the standard and supplemental specifications covering conditions applicable to the project.

- **Plan Changes and/or Special Agreements** are documents describing and detailing **changes** to the contract. These documents establish reason(s) for the change(s), specification requirements, method of measurements, basis of payment, etc. Project engineers prepare change orders, but **only** the Chief Engineer can authorize a plan change, and sign the change order.

- **Notice to Proceed** is a written notice allowing the contractor to proceed with the contract work. Printed on the notice is the date the contract began.

Complete the following questions, and record the correct answer in the blank.

a. The **CONTRACT** covering the construction project is a _____between Louisiana Department of Transportation and Development, and the contractor.

b. Which document asks the contractor to submit a cost bid for a project?

_____

c. Contractors base their bid on the materials and labor necessary to construct the highway project. Which document tells the contractor **what** to construct and **where** to construct it? _____

1-1 Contract definitions *(continued)*

d. List the **three** categories regarding specifications for a project.

1. _____
2. _____
3. _____

e. After the contractor completes an estimate, they fill out and submit a _____.

f. The Department issues a (n) _____allowing the contractor to **start** the project.

g. What can change the contract after the start of the project? _____

h. Which document(s) are the most referenced when used to inspect; what the contractor builds, where the contractor builds, and how the contractor builds._____.

i. Record the name of the document the project engineer prepares when a change in plans is required. _____.

j. Occasionally, a contractor must perform extra work, to complete the project. Prior to the contractor performing the work, the Chief Engineer signs a _____.

1-2 **<u>Standard Specifications</u>** are directions, provisions, and requirements that apply to work performed on **<u>all</u>** contracts. Standard Specifications show the location, type, dimensions, and other details of the prescribed work.

- **<u>Supplemental Specifications</u>** are additions, revisions, or amendments to the Standard Specifications adopted after the specification book was printed.

- **<u>Special provisions</u>** are additions to both the **standard** and **supplemental** specifications written for, and applied to a specific contract.

1-2 Specifications *(continued)*

a. Which specifications apply only to a specific project under contract?

_____.

b. What specifications apply to all projects? _____.

c. Special directions applicable to specific projects are _____.

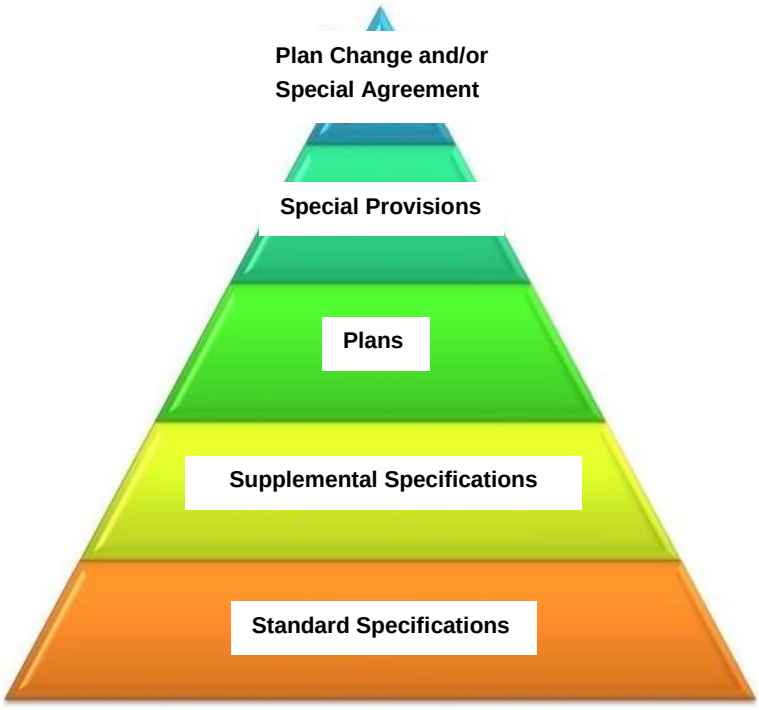
d. A revision or amendment to the Standard Specifications is a _____.

1-3 The triangle shown below indicates a top down priority hierarchy. Notwithstanding Plan Changes and/or Special Agreements, here are the four most referenced divisions of the construction contract.

- **Special Provisions**
- **Plans**
- **Supplemental Specifications**
- **Standard Specifications**

Sometimes there may be differences between the four.

Listed below, and illustrated to the right, is the preferred order used to clarify possible contract discrepancies.



1 – **<u>Special Provisions</u>**: directions and requirements for a **specific** project.

2 – **<u>Plans</u>**: drawings and notes for a **specific** project.

3 – **<u>Supplemental Specifications</u>**: the latest additions and/or revisions to the Standard Specifications.

4 – **<u>Standard Specifications</u>**: directions, requirements, and provisions, used for **<u>all</u>** projects.

1-3 Specifications *(continued)*

a. List the **procedural order to follow** with regard to clarification of possible contract discrepancies.

1. _____

2. _____

3. _____

4. _____

THE ROLE OF HIGHWAY PLANS

1-4 Highway Plans are **drawings** and **notations** for a specific project. They describe:

- **WHAT** to build
- and **WHERE** to build.

In order to read a set of plans, it is important to accurately interpret and understand each drawing and notation.

Plan sets are very important construction tools. A **plan set** contains many different plan sheets. Sheets within a plan set **relate** to each other. Most often, information pertaining to a particular feature of the project appears on more than one sheet. To ensure proper construction of the project, it requires accurate interpretation of the **ENTIRE set of plan sheets**. Furthermore, it is essential to keep the plan set clean and in order.

Write the correct word(s), or phrase in each blank.

a. To read a set of plans it is important to accurately _____ and understand what is meant by each drawing and notation.

b. The plans indicate _____ to build and _____ to build a project.

c. Sheets within a set of plans _____ to each other. Information pertaining to a particular feature of the project often appears on more than one sheet.

1-4 The Role of Highway Plans *(continued)*

d. It is very important to keep a plan set _____ and in _____.

Producing a complete highway plan set requires much time and effort. The finished product is a set of detailed instructions composed of many specific drawings and notes. Because of this, learning how to read and understand Highway Plans is not complicated.

Chapter Two starts the process in which we begin to clarify and interpret drawings and notes.

***Note**: Check your responses against answer sheets found at the end of this manual. If you missed MORE than three questions, review this chapter again and correct any wrong answers before progressing.*

TRAINING NOTES

CHAPTER 2
TITLE SHEETS

INTRODUCTION

Each set of highway plans has different sheets containing information about the project. This information is in the form of symbols, drawings, and notes. Reading and understanding the information each symbol, drawing, and note represents requires examining each sheet in detail.

The **TITLE SHEET** is Sheet 1 in the plan set. The words "**SHEET NUMBER 1**" appear in the upper right corner of the page. Title Sheets provide information such as the general location of the project, traffic data, revisions, and approvals.

Similar to the Table of Contents in a book, the **INDEX** is the table of contents for a plan set. The **INDEX** is located in the upper **left** corner of the Title Sheet. On occasion, when there is not enough space on the Title Sheet, the **INDEX** may be placed on the next sheet (Sheet 1a).

This chapter reviews material from two sets of highway plans,
State Project H. 000238 - Drain Canal Bridges on U.S. Hwy 90 and
State Project 268-01-0012, I-12 – DUMPLIN CREEK.
Several topics are covered:

- Interpreting highway plan drawings
- Sections
- Townships
- Ranges
- Stationing
- Survey data

Information in this chapter relates to material in other chapters of this course.

Throughout this chapter, consecutive **TOPIC** numbers cover information relevant to Title Sheets. Occasionally, topic numbers reference one another.

Introduction *(continued)*

As in the previous chapter, review questions periodically appear, complete each question, as they will become useful study guide material.

Open your Plan Book to the first page, the Title Sheet (**DRAIN CANAL BRIDGES ON U. S. HWY 90**) and keep this manual nearby. Look over the Title Sheet and locate these features: **INDEX, VICINITY MAP, LAYOUT MAP, SCALE, and TRAFFIC DATA.** Another important feature is the **TITLE BLOCK,** a narrow series of rectangles containing information located along the right edge of the sheet.

PROJECT IDENTIFICATION

2-1. It is important to obtain the correct set of plans for any given project. There are three ways to identify a project. Project identifications are on the Title Sheet.

FEDERAL PROJECT NUMBER(S)
STATE PROJECT NUMBER(S)
PROJECT NAME

2-2. **Fill in the blanks with the correct answer.**
There are two types of project numbers used to identify a project.

a. The _____ project number and the _____ project number.

A state project number alone can positively identify a project. In fact, if a project has no federal funding, there is not a Federal Project Number.

2-3. Plan sheets using the LADOTD "H" series numbering system show the **TITLE BLOCK** along the right edge of each plan sheet. Legacy Plans generally show the Title Block in the lower right corner.

Title Blocks contain information pertinent to each stage of the project. Orient (turn) the Plan Sheet Book PORTRAIT so the Title Block is located at the bottom of the sheet. Find the following items within the Title Block, after locating each, place a check in the box.

- ☐ The DOTD seal
- ☐ The words TITLE SHEET
- ☐ S.P. H.000238
- ☐ ROUTE US-90
- ☐ DRAIN CANAL BRIDGES ON US-90
- ☐ State of Louisiana seal
- ☐ The REVISION /DESCRIPTION BOX
- ☐ Spaces for Revision dates and signatures
- ☐ The name of the CHECKER(s)
- ☐ The DATE the plans were drawn
- ☐ The name of the Designer
- ☐ The PARISH
- ☐ Space for a Federal number
- ☐ STATE PROJECT NUMBER
- ☐ SHEET NUMBER 1
- ☐ The Contractor logo

2-4. List the three things on the Title Sheet that identify a project.

a. _____
b. _____
c. _____

d. Each of these three things aid in _____ the project.

e. The three project identifications are found on the _____ Sheet.

f. The Title Sheet is sheet number _____ in the set of plans.

g. Is a FEDERAL PROJECT number recorded in the Title Block? _____

h. What is the STATE PROJECT NUMBER (S.P.)? _____

i. The DESIGNER of record is _____.

j. The CHECKER of record is _____.

k. What PARISH is recorded in the Title Block? _____

l. What DATE is recorded in the Title block? _____

m. What is the PROJECT NAME? _____

2-5. Examine the different features on the Title Sheet. Notice that information found in the TITLE BLOCK repeats throughout the sheet.

For instance, near the middle, at the top of Sheet 1 OF 1, we find the **STATE PROJECT NUMBER NO. (S.P.)** This information is above the LAYOUT MAP in an area referred to as the **PROJECT CAPTION.**

The **PROJECT CAPTION** consists of the following items, in this order.

- The federal aid project number(s), F.A.P.
- The state project number(s), S.P.
- The project name
- The parish
- The route number

Fill in the blanks with the correct answer.

a. Record the PROJECT NAME found on Sheet 1, the Title Page.

_____

b. What is the F.A.P. ? _____

c. What is the S.P. ? _____

d. The project is located in _____ parish.

e. The project is located on _____ (hint = highway)

2-6. Look at the Title Sheet; notice the print captions around the Layout Map. Under each caption, there is a darkened triangular shape, showing a curved “leader-line” leading from the project numbers to points showing the beginning and ending points of the project(s).

List three places on the Title Sheet that indicate the State Project Number.

a. _____

b. _____

c. _____

List three ways to identify a project.

d. _____

e. _____

f. _____

2-7. **FEDERAL PROJECT NUMBERS** are located:

- In the Title Block
- In the Project Caption
- Around the Layout Map

STATE PROJECT NUMBERS are located:

- In the Title Block
- In the Project Caption
- Around the Layout Map

The Title Block and the Project Caption contain the **PROJECT NAME.**

UNDERSTANDING TITLE PAGE INFORMATION

2-8. Highway plans include many sheets of information, each containing symbols, drawings, and notes. Understanding the information on the Title sheet will be useful when reading the other sheets within this Plan Book.

Take a closer look at the **Project Caption**. Use the Project Caption and the LAYOUT MAP together. This is a road and bridge project located in JEFFERSON PARISH on United States Highway 90 (U.S. 90.) The project location is near the unincorporated community of Waggaman, Louisiana.

Notice the **F.A.P**. (Federal Aid Project) number at the top of Title Sheet 1. The prefix letters indicate the federal funding category for the project. Federal funding number assignments have changed over time; their meanings will not be addressed.

2-8. *(continued)*

However, certain prefix acronyms remain constant. Listed below are common prefixes associated with Federal-funding categories.

STP = Surface Transportation Program.
I = Interstate
BR = Bridge Replacement
IM = Interstate Maintenance
NH = National Highway System projects
ER = Emergency Relief projects
On occasion, additional funding categories are initiated.

2-9. On Federal Aid Projects, the FHWA (Federal Highway Administration) provides partial funding for the project. Often the acronyms “ISTEA” or “TEA-21” are used. ISTEA stands for the Intermodal Surface Transportation Efficiency Act of 1991, and TEA-21 refers to the later Transportation Equity Act of the 21st Century.

Fill in the blanks with the correct answer.

a. What does the prefix “STP” indicate?_____
b. What does “BR” mean? _____
c. What is “TEA-21”? _____

PROJECT NUMBERS

2-10. Reading and understanding highway plans with accuracy is critical to this course. Individuals taking this course need to be familiar with the department's current and previous project numbering systems.

Three key points to the State Project numbering system:

1. Project numbering is sequential.
2. Projects are created from pre-established templates.
3. DOTD will utilize four different **project templates**:

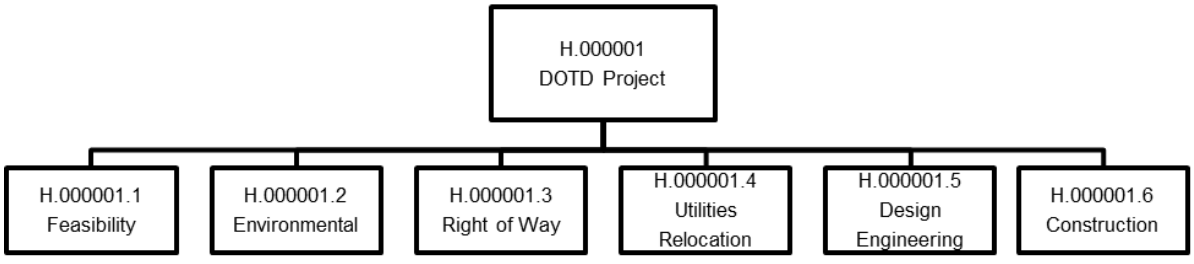
   A. Construction
   B. Single Activity
   C. An emergency event for FHWA
   D. An emergency event for FEMA

The numbering system creates an accurate process of tracking and acquiring statistical data for each State Project.

***** Flow charts depicting the "breakdown" of the State Project numbering system are shown below, and on the next page.

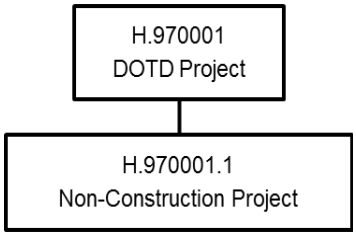
***** Notice the configuration of each project number per **template**, i.e. the first two digits, the ending digits, and decimals.

A. **Construction** - used for any project when tracking throughout **six phases** is required.

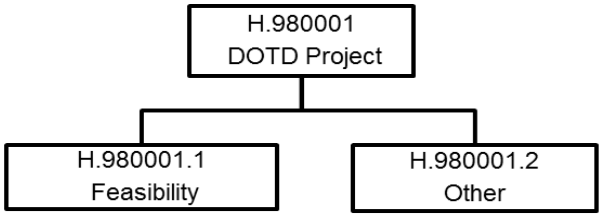


2-10. *(continued)*

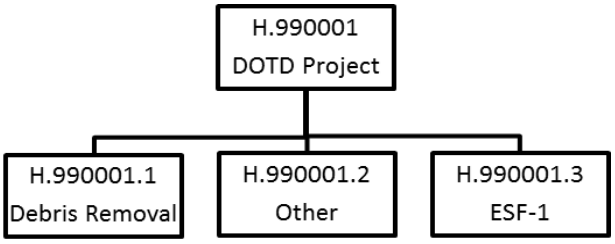
B. **<u>Single Activity</u>** - authorizations such as State Planning & Research (SPR) equipment purchases, signalization inventory, pooled fund studies, will use a single-phase template structure.



C. This template structure will be primarily used for collecting DOTD personnel, equipment, and materials costs immediately prior to, during, and immediately after **<u>an emergency event for FHWA</u>** Reimbursement.



D. This template structure will be used primarily for collecting DOTD personnel, equipment, and materials costs immediately prior to, during, and immediately after **<u>an emergency event for FEMA</u>** Reimbursement.



2-10. **PROJECT NUMBERS** *(continued)*

The previous State Project numbering system *(sometimes referred to as "Legacy" numbers.)* is not entirely different from the current project numbering system. It existed primarily for recording cost data related to a particular segment of roadway.

Understanding the structure of the FORMER DEPARTMENT NUMERICAL CODING SYSTEM is equally important, as they are valuable sources of information.

Access to any State Project Number is possible using the application "LaGov ERP, Project Crosswalk Search" found under the heading "Project/Highway Information" on the DOTD Intranet home page

Here is a breakdown of the previous numbering system *(Legacy Numbers,*).

- State Highways are divided into segments called **CONTROLS**. Each CONTROL is further divided into smaller segments called **SECTIONS**. This system enables the department to record costs for relatively short stretches of road.

- **A CONTROL is identified with 3 digits**, and a **SECTION comprises 2 digits**.

- The former state project number system consisted of the CONTROL-SECTION numbers of the highway project and a job number for that section.

* For instance, take this Legacy Project Number (previous State Project number)

268 - 01 - 0012

268 = the CONTROL NUMBER for this project.
01 = the SECTION NUMBER for this CONTROL.

Combined, the CONTROL-SECTION is 268-01

0012 = the twelfth PROJECT on this CONTROL-SECTION.

Using the beginning and ending log mile of a project can further narrow the location of work on a control-section.

2-11. Interpret these Legacy Numbers *(previous State Project numbers.)* Refer to the information from Topic 2-10, FILL IN THE BLANKS with the correct Control Number, Section Number, and Number of Projects.

	Control Number	Section Number	Number of Projects
064-06-0036			
407-03-0018			
829-10-0013			
213-08-0007			

2-12. Fill in the blanks with the correct answers. Use the information from Topic 2-10 to interpret the following State Project numbers.

a. State Project number H. 990001 is an example of _____

b. State Project number H. 980001 is an example of _____

c. (True or False) State Project H. 970001.1 is a construction project._____

2-13. DOTD utilizes four different **project templates, they are**:

a. _____

b. _____

c. _____

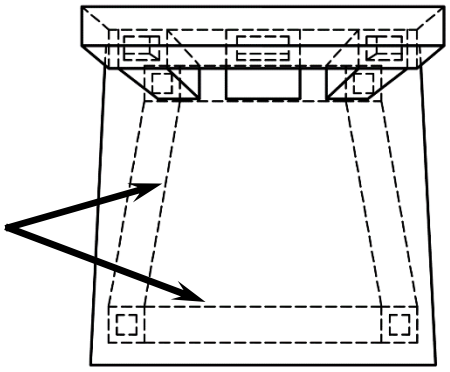
d. _____

Note: Correct the wrong answers on this page. Review the necessary parts, before moving to the next topic. If necessary, re-read topics 10 – 13

HIGHWAY PLAN DRAWINGS

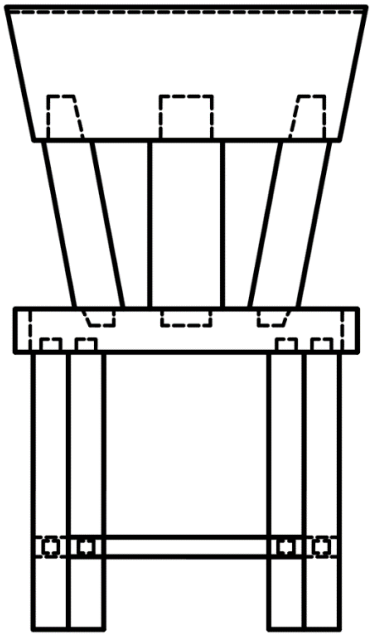
2-14. Remember, many drawings constitute a set of plans, each showing specific construction details. A drawing may depict or illustrate the outside of an object or the inside of an object. It may also show the object from above, the side or the front. Drawings give clear and concise pictures (instructions) of how to orient and construct objects, for example; roadways, bridges, fences, pipes, ditches, etc. Objects drawn on plans generally appear in two or three forms, **Plan Views, Elevations, and Sections**.

2-15. For example, this is a **PLAN VIEW** of a chair. **A PLAN VIEW views objects from directly above**. Simply put, you are looking **DOWN** at the object.

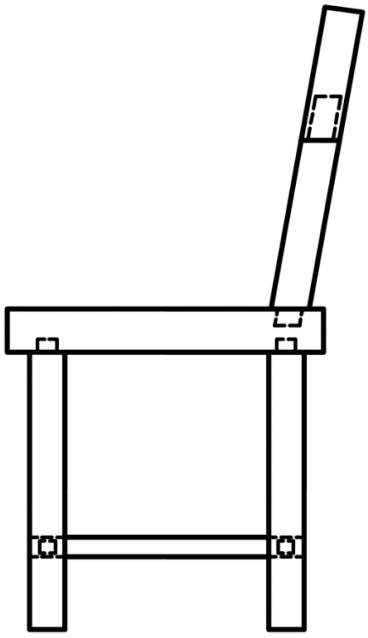


These dashed lines indicate parts of the chair not SEEN from this viewpoint. It is as if the person viewing has "x-ray" vision, able to see objects from beneath or behind the current vantage point.

2-16. An **ELEVATION VIEW** displays the **height** of an object from the front, rear, or either side.

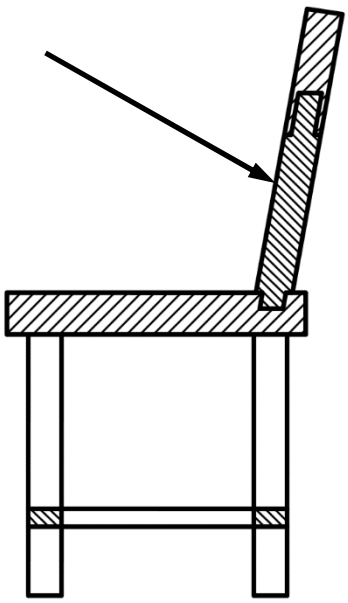


Front Elevation



Side Elevation

2-17. This is a **CROSS-SECTION VIEW** of a chair.

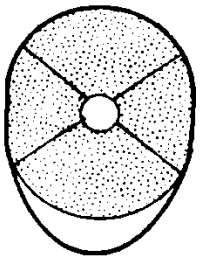


It is also a side view of the chair. Slicing through it exposes the inside of the seat, back and cross braces. **Cross-Sections** cut away parts of an object revealing the hidden details inside.

2-18. Shown below are four different views of a cap.

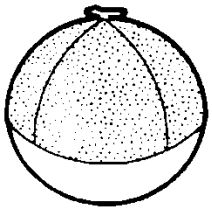
- CROSS-SECTION VIEW
- PLAN VIEW
- FRONT ELEVATION VIEW
- SIDE ELEVATION VIEW

In the blank provided, write the correct name of each view.

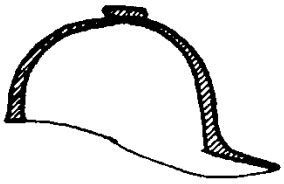


a. _____

c. _____



b. _____



d. _____

Note: Correct the wrong answers on this page, and be certain that you understand the corrections before moving to the next topic. If necessary, re-read pages 10 & 11.

2-19. PLAN and ELEVATIONS VIEWS are OUTSIDE VIEWS of an object, whereas CROSS-SECTIONS are INSIDE VIEWS of an object.

Remember, Cross-Sections cut away parts of an object revealing hidden details. Section "cuts" are made at any point. **Cutting Plane Lines** indicate the exact point of the "cut."

2-20. Refer to Sheet 60 in the Highway Plan Book *(State Project, I-12 – DUMPLIN CREEK.)*

Although this Detail Sheet was drawn on a set of plans utilizing the "old" title block and S.P. numbering system, the information remains pertinent to this part of the lesson.

Sheet 60 is a special detail for a **SIDE DRAIN SAFETY END**. On the right side of the sheet is a detail for a **PRECAST ALTERNATE**.

Cutting Plane lines are used throughout the plan set. Cutting Plane lines indicate the exact point where the engineer wants to show more detail of an object. Notice the top drawing (Plan View) shows a cutting plane line with a capital "A" on each arrow. This is called Section A-A.

The drawing of Section A-A appears at the bottom right of sheet 60.

Note Section A-A is looking toward the LEFT end of the pipe. In this example, the drawings for Section A-A would be the same if the arrows had pointed to the RIGHT end of the pipe. Always observe the direction the arrows are pointing. The cross-section itself will always be identical, but features beyond the cross-section may be different.

2-21. Examine the **PRECAST ALTERNATE** Plan, Profile, and Section A-A drawings on Sheet 60. **Answer the following questions:**

a. Which way do the Cutting Plane arrows point, right or left? _____
b. How thick are the side concrete walls? _____
c. What is the maximum size of pipe for this detail? _____
d. What is the clearance for the #4 Bending Bars? _____

2-22. Other views are often necessary on a set of plans; these views are CROSS-SECTION, LONGITUDINAL CROSS-SECTION (lengthwise,) ELEVATION (height of object) and PLAN (from above object.)

2-23. Refer back to the Title Sheet for DRAIN CANAL BRIDGES ON U.S. 90. It provides two examples of PLAN VIEWS, the **Vicinity Map,** and the **Layout Map**.

PROJECT LOCATION

Along with the Title Block, Project Caption, and the Layout Map there is the **Vicinity Map**.

Find the **Vicinity Map** on Sheet 1 of the DRAIN CANAL BRIDGES ON U.S. 90; it is located in the upper right corner next to the Title Block.

2-24. The **Vicinity Map** answers the question: what Parish or Parishes is the construction project to take place? Notice the curved leader line pointing to **Jefferson Parish** in the State of Louisiana. This verifies that the parish is the same as the one found in the Title Block and the Project Caption. The Parish or Parishes now appear in three places. Not only does the Vicinity Map verify the Parish, it also indicates the area of the State where the project takes place.

List three places indicating the Parish where the DRAIN CANAL BRIDGES ON U.S. 90 construction project is to take place.

a. _____ **b**. _____ **c**._____

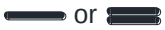
2-25. Showing a closer plan view of the project is the Layout Map. It is located in the center of the Title Sheet. Typically, rural projects use parish maps, while urban projects use city maps.

This project uses part of a Parish Map; notice the north arrow next to the map indicates the map orientation.

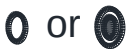
2-26. Space limitations require maps to use symbols to represent actual objects, while abbreviations are often used in place of complete words.

For example, a line representing a highway is often accompanied with another symbol, indicating that it is a state highway.

Here are some common map symbols.

HIGHWAYS 

RAILROADS 

CITIES 

CREEKS & BAYOUS 

PARISH BOUNDRIES

US HIGHWAYS 

STATE HIGHWAYS 

INTERSTATE HIGHWAYS 

2-27. Find Sheet 1 for *State Project, I-12 – DUMPLIN CREEK* in the Highway Plan Book.

Using the common map symbols and the Layout Map, answer the following questions:

a. Record the number associated with the US highway found on the Layout Map.

_____

b. What Interstate highway is on the Layout Map?

_____

c. List the State highways found on the Layout Map.

_____

d. What other highways appear on this Layout Map?_____

2-28. Refer again to Sheet 1 (**Drain Canal Bridges on U.S. 90**) in the Highway Plan Book; locate the LAYOUT MAP.

Layout Maps indicate the vicinity of the proposed project with a heavy line. In this case, State Project - H. 000238 is located on U.S. 90, west of Waggaman, Louisiana.

NOTE:

On occasion, it is possible to have more than one state project number associated with a construction project. Sometimes a project involves more than one control-section. Refer back to Sheet 1 in the Highway Plan Book *(State Project, I-12 – DUMPLIN CREEK,)* notice the three "legacy" State Project numbers.

2-29. Turn back to the Title Sheet for S.P. H.000238. Observe the print captions around the Layout Map. Under each caption appears a darkened triangular shape, accompanied with a curved "leader" line indicating the beginning and ending for each part of the project. Also, note each caption indicates a **station number (STA.)** and **control-section log mile (C.S. Log Mile.)**

A **STATION NUMBER (STA.)** identifies a specific point on a project. Station numbers are written xx + xx (e.g., 30+00). The control-section log mile measures the distance from the beginning of a control-section in miles.

a. What is the station number for the BEGIN SITE NO. 1 of State Project H. 000238? _____

b. What is the station number for the END SITE of S.P. NO. 1 of State Project H. 000238? _____

c. What is the control-section log mile for the END SITE NO. 2 of State Project H. 000238? _____

d. What is the F.A.P. number for the BEGIN SITE NO. 1 of State Project H. 000238? _____

2-30. Found below the Layout Map on the Title sheet for DRAIN CANAL BRIDGES ON U.S. 90 is the drawing scale.

A **SCALE** indicates length or measurement on the map equal to a specific length or measurement on the actual ground.

The SCALE written on the title sheet applies to the original FULL SIZE SHEET. For the purposes of this course, the sheets within the Plan Book have NOT been reduced proportionately, and are therefore considered “Not to Scale” (NTS).

At times it is necessary to measure a distance on a full size plan sheet using an “engineer’s scale.” Fortunately, each sheet will indicate a scale or scales; be sure to use the correct scale for each drawing(s).

When Plan Set sheets are reduced, check to see if the sheet was reduced proportionally (i.e. full size sheets reduced to half size sheets). The scale of the drawing(s) will also change proportionally.

For instance, measuring distances on half-size sheets with the Engineer Scale will require doubling the scale.

Here is an example. 1″ = 2,000 feet would become 1″ = 4,000 feet.

Special Note:

- Instead of interpreting measurements with the Engineer Scale “20,” measurements would be interpreted using the Engineer Scale “40.”

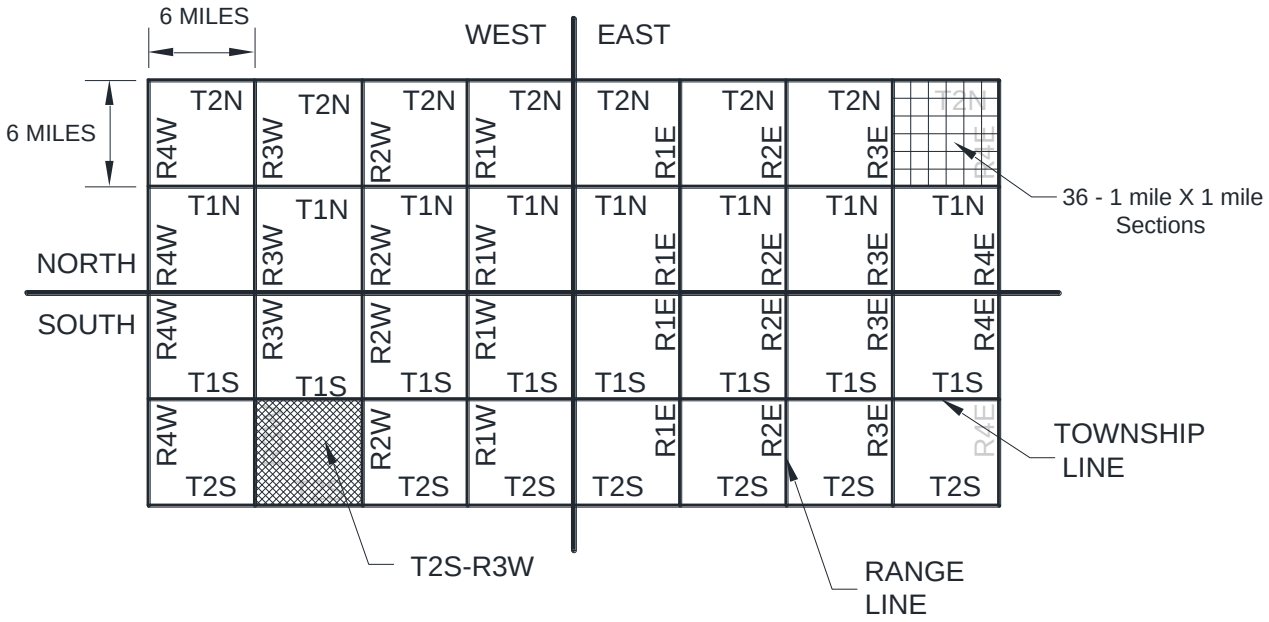
Use the Layout Map found on the Title Sheet for the DRAIN CANAL BRIDGES ON U.S. 90 to complete these statement.

a. The scale of the layout map is _____.

b. Proportionally reducing the size of Plan Set sheets requires proportionally changing the _____.

SECTIONS, TOWNSHIPS AND RANGES

2-31. Throughout the United States, imaginary lines divide the land into unique parcels, making each area easily identifiable. These lines are the starting points for numbering townships. Below is an illustration showing the many components that make up Townships and their related Sections.

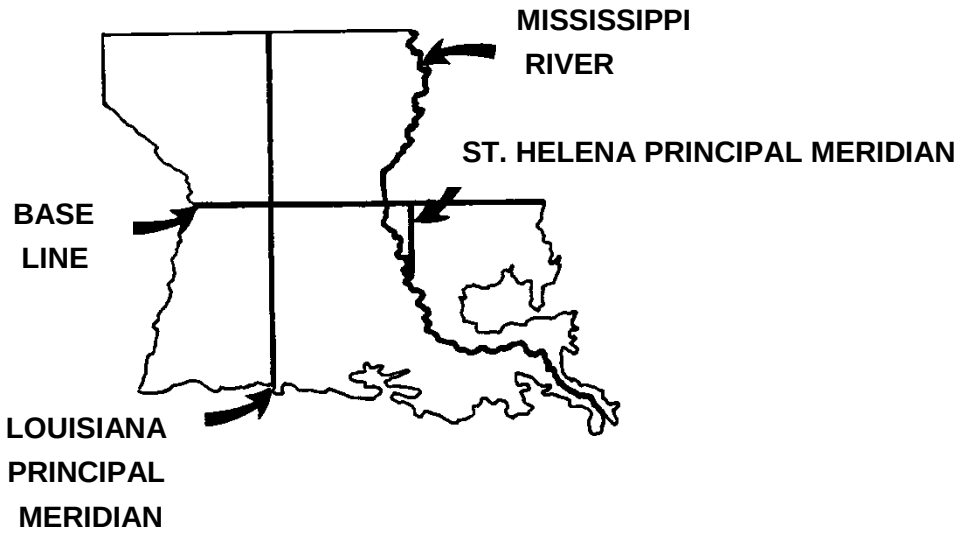


Locate the following items in the diagram above:

- A **North-South Dividing Line** separating the land into two parts: land north of the line and land south of the line.
- A **West-East Dividing Line** separating the land into two parts: land west of the line and land east of the line.
- **TOWNSHIP LINES** are lines parallel to the north-south dividing line at **six-mile intervals**.
- **RANGE LINES** are lines parallel to the west-east dividing line at **six-mile intervals**
- The **Township Number** for the **shaded area** is **T2S-R3W.**
- **36 one-mile square SECTIONS** divide most Louisiana townships.

a. The township and associated sections for the State Project, I-12 – DUMPLIN CREEK are written at the top of sheet 96 in the Highway Plans Book. Write the information here. _____

2-32. Louisiana uses one north-south dividing line called a **BASE LINE**.
The Louisiana State map below shows the approximate location of the Base Line.



2-33. Louisiana has two west-east dividing lines called **PRINCIPAL MERIDIANS**.
The map above shows the approximate location of the meridians.

- The **Louisiana Principal Meridian** references parts of the State **west** of the Mississippi River.
- The **St. Helena Principal Meridian** references parts of the State **east** of the Mississippi River.

***** The **Base Line** aids in the location of **all** township line numbers for Louisiana. Finding the correct **Range Line** for a specific township requires referencing a specific Principal Meridian.

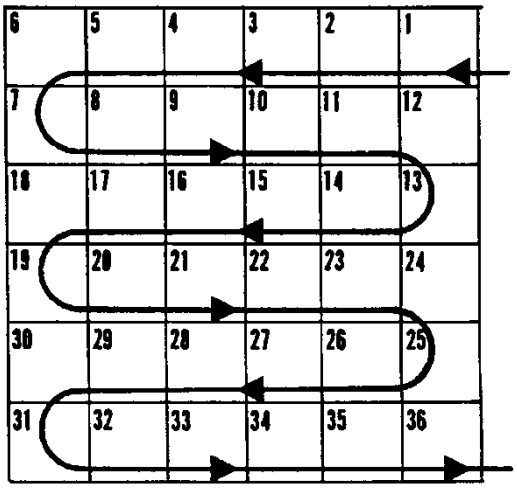
2-34. Below are the explanations for the letters and numbers referenced in the typical township number, **T2S-R3W**

T = Abbreviation for TOWNSHIP	**R** = Abbreviation for RANGE
2 = TOWNSHIP line number 2	**3** = RANGE line number 3
S = Abbreviation for SOUTH	**W** = Abbreviation for WEST

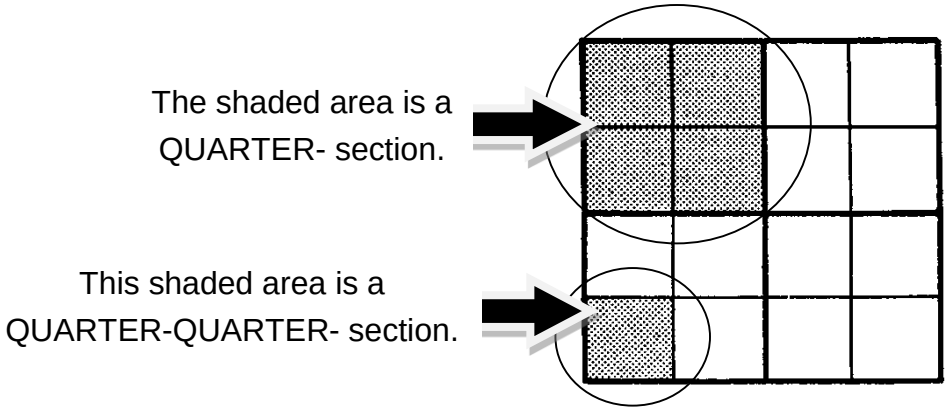
When reading a township number, say, "**Township 2 South, Range 3 West"**

2-35. **SECTION LINES** depict boundaries between two sections of a township, or between two townships. Sections and townships are measures of land area.

- **36 one-mile square SECTIONS** divide most Louisiana townships (see Township T2N-R4E referenced in topic 31.)
- The diagram on the right shows the numbering system used for with the rectangular grid system.



2-36. Sections are divided into **QUARTERS**, giving **four quarter-sections**. In turn, each quarter section divides into four equal parts, resulting in **16 quarter-quarter sections**. Below is a drawing of a section with "**quarters**" and "**quarter-quarters**."



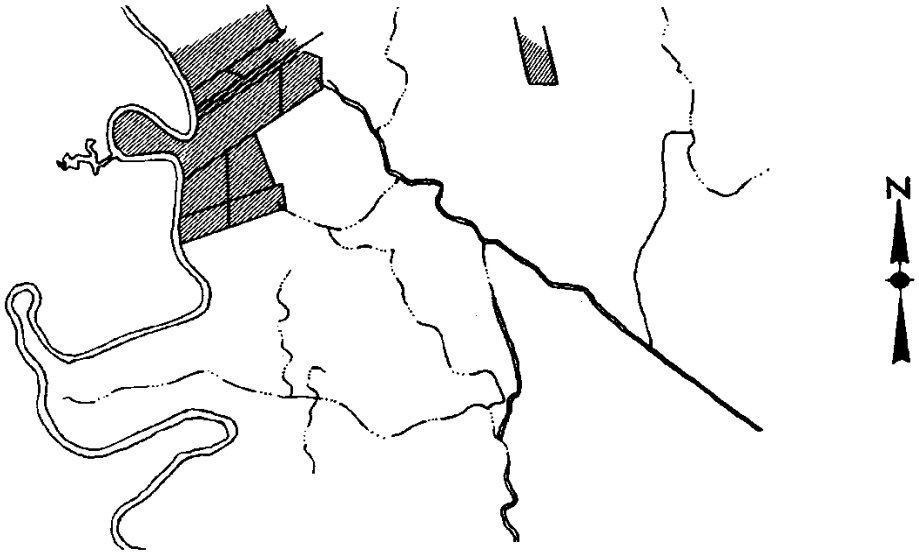
It is possible to live in the ***"Southwest Quarter of the South West Quarter of Section 5 in Township 2 North, Range 4 East."***

2-37. Most Louisiana townships have 36 one-mile square sections, each containing **640 acres**; however, there are some Louisiana townships with more than 36 sections. Sometimes, township sections are not 640 acres because odd shapes carried over from previous surveys altered placement of the Section Lines.

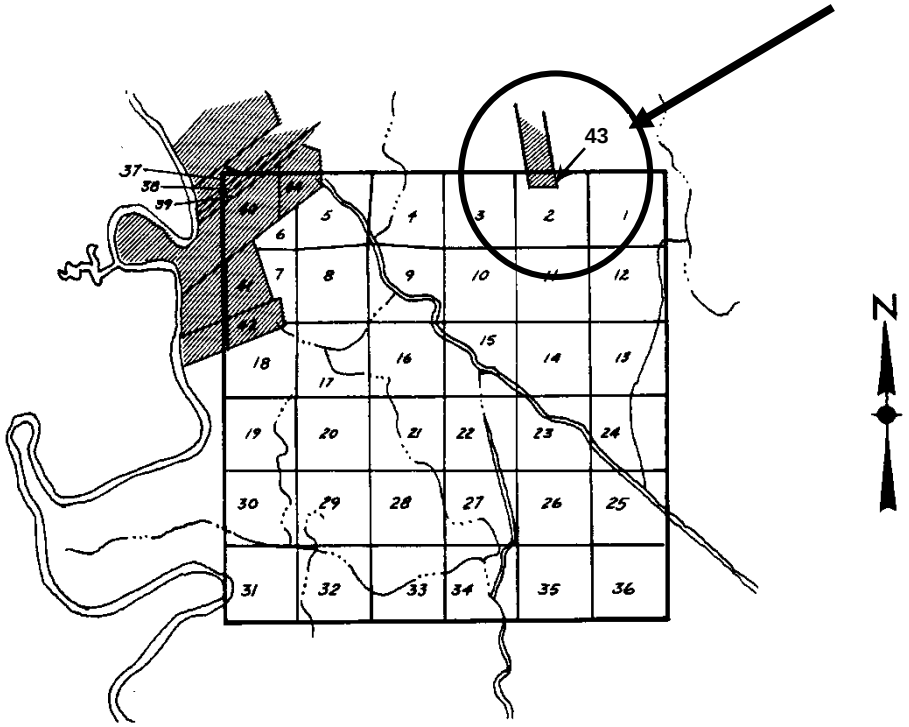
2-37. *(continued)*

Some time ago, surveyors measured land utilizing natural boundaries such as the edge of a river or bayou. These rivers and bayous were the primary means of travel, and many people bought land wanting river or bayou frontage. The State surveyed some of this land before adopting the rectangular grid system for township designation.

A map of that time may have looked like the one below. Notice the odd shaped rectangles representing properties along the river. These previously surveyed parcels of land retained their odd shaped boundaries, and later became sections when the rectangular grid system was adopted.



2-38. The map from the previous page is an actual township located in Ouachita Parish. Below, the same map has been overlaid with the 36 Section (one-mile-by-one-mile) rectangular grid. Notice Section "2" includes a portion of previously surveyed property. This portion of "previously surveyed property" received its own section number, Section 43, as did others. Unaffected parcels within the grid received assigned section numbers.



2-39. The following questions pertain to topic numbers 31 - 38; write the correct answers in the blanks. Try to NOT look back to check for answers until all the questions have been answered.

a. How many sections are in a township? _____

b. How many quarter sections are in a township? _____

c. How many quarter sections are in one section? _____

d. How many quarter-quarter sections are in one section? _____

e. How many quarter-quarter sections are in a township? _____

f. A section measures _____mile(s) on each side.

g. A quarter section measures _____mile(s) on each side.

h. A township measures _____mile(s) on each side.

i. A quarter-quarter section measures _____mile(s) on each side.

2-39. *(continued)*

j. How many acres are there in a quarter section? _____

k. How many acres are there in a section? _____

l. How many acres are there in a township? _____

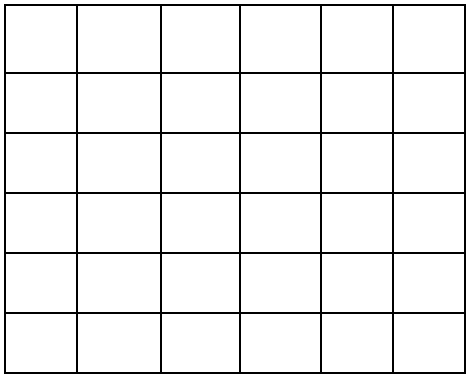
m. How many acres are there in a quarter-quarter section? _____

Refer to the information in topic 31 found on page 17, use it to answer the next two questions.

n. Record the number of the township due NORTH of T2S-R4W. _____

o. Record the number of the township due WEST of T40N-R10W. _____

p. Using the previously mentioned numbering system for sections within a township, **correctly number** the sections in this diagram.



q. How many Principal Meridians are located in Louisiana? _____

r. How many Base Lines are in Louisiana? _____

s. Base Lines are used to find range lines. (true or false) _____

t. A Principal Meridian is used to find township lines. (true or false) _____

STATIONING

2-40. Locating various points along the length of a project requires the use of **STATION NUMBERS**. These numbers appear on the plans and correspond to stakes driven in the ground throughout the job site.

Here is a good way to remember how **STATION NUMBERS** work.
Just as 12 inches make 1 foot, 100 feet make 1 station.

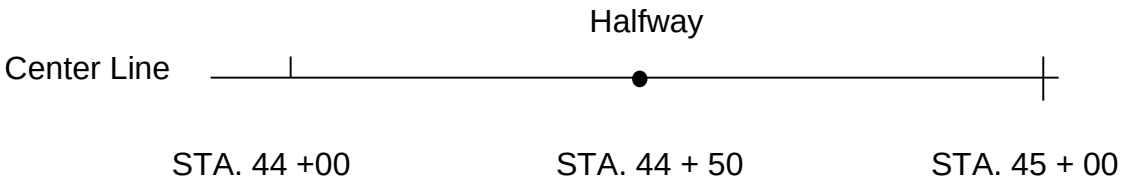
This is always true whether it is between stations 1 and 2, or between stations 360 and 361.

a. What is the distance between stations 44 and 46? _____

2-41. If the distance between stations is 100 feet, then, halfway between each station is 50 feet. To record this location, write **+ 50** after the station number.

Write + 00 after the station number when recording a point directly on a station.
STA. is an abbreviation for station.

Here is an example.



- The point directly on station 44 is **STA. 44 + 00.**
- A point halfway between stations 44 and 45 is **STA. 44 + 50**.

2-42. Any point between two stations records in a similar fashion. For example, a point on the centerline 5 feet ahead of STA. 44 records as STA. 44 + 05. Similarly, a point 99 feet ahead of STA. 44 records as STA. 44 + 99. In addition, a point 100 feet ahead of STA. 44 records as STA. 45 + 00.

Fill in the blanks with the correct answer to the questions.

a. Record the station number 43 feet ahead of STA. 8 + 00. _____.

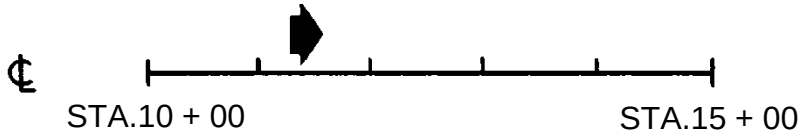
b. Record the station number 44 feet ahead of STA. 244 + 00. _____.

c. Record the station number 160 feet ahead of STA. 10 + 00. _____.

2-43. Generally, station numbers get larger as you go from:
WEST to EAST OR SOUTH to NORTH

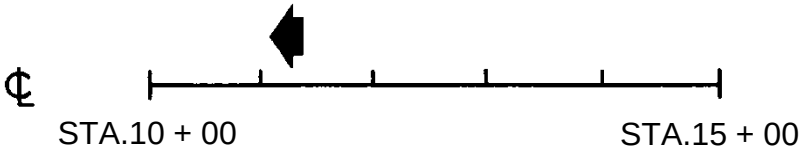
- **Station numbers get larger when you look in this direction.** 

You are looking at the **LINE AHEAD**.



- **Station numbers get smaller when you look in this direction.** 

You are looking at the **LINE BACK**.



2-44. Subtract the lower station number from the higher one to find the distance between any two points along a centerline. Ignore the PLUS sign when performing calculations.

For example, to find the distance between station 40 + 80 and station 22 + 60, do this:

```
  4080   (Ignore the plus sign)
- 2260
------
Answer  1820 feet
```

a. Use this space to calculate the distance between these stations 402 + 30 and 393 + 44.

2-45. In the first part of topic 44, the distance between the two stations used in the example was 1820 feet. Here is another way to check that distance.

The distance from station 22 + 60 to station 23 + 00 =	40 feet
The distance from station 23 + 00 to station 40 + 00 =	1700 feet
The distance from station 40 + 00 to station 40 + 80 =	80 feet
Total distance	1820 feet

2-46. **FIND THE DISTANCE BETWEEN THESE STATIONS. Use the space provided to show calculations**

a. STA. 17 + 40 and STA. 43 + 03

c. STA. 39 + 04 and STA. 623 + 40

b. STA. 757 + 00 and STA. 757 + 14

d. STA. 32 + 03 and STA. 425 + 05

2-47. Measurements play a critical role in road construction; therefore, measurements are to **one-hundredth of a foot**.

For example, 13.25 feet = 13 and 25 one-hundredths of a foot.

FIND THE DISTANCE BETWEEN THESE STATIONS. Use the space provided to show calculations

a. Station 7 + 41.50 and station 39 + 00.00

b. Station 6 + 75.00 and station 11 + 23.40

EQUATIONS

2-48. During a project, changing a station number is possible and the reasons vary. Sometimes, a station number becomes too large; then again, changes may be due to a "re-survey." Whatever the cause for station number changes, it is important to remember that **EQUATIONS** are the recording devices that indicate the station number change.

EQUATIONS are records showing where station numbers CHANGE.

Equations similar to the example below appear above or on the side of the layout map.

	REMEMBER…
Equation = + 1.00 STA. 3 + 40.00 L.B. = STA. 3 + 39.00 L.A	**Always change the number from a LINE BACK to a LINE AHEAD.** **L.B. = Line Back L.A. = Line Ahead**

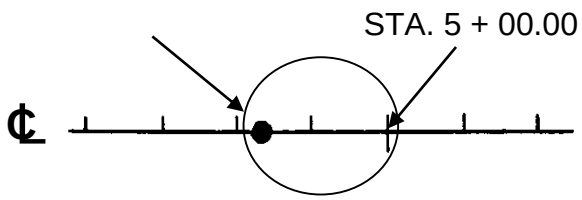
2-49. Here is how to interpret an equation.

This station number indicates a point 340 feet from the starting point of the project.

This station number indicates a point 339 feet from the starting point of the project.

Equation = + 1.00
STA. 3 + 40.00 L.B. =
STA. 3 + 39.00 L.A

The point is still the same in both cases as indicated on the centerline below.



The real distance from the starting point of the project is the same for both station numbers. The difference between the two station numbers is one foot. The new station number, **LINE AHEAD**, is one foot short of the real distance.

2-49. *(continued)*

This "one foot" is the **EQUATION,** and it is a "**PLUS"** equation. Adding the equation to the LINE AHEAD distance obtains the real distance from the starting point.

In other words:

line ahead distance (L.A.)	339′
plus the equation	+ 1′
equals line back distance (L.B.)	340′

2-50. **REMEMBER:**

Add a plus equation to line ahead (L.A.) to equal line back (L.B.)

EXAMPLE

Step 1	**Step 2**	**Step 3**
Equation = +7.80	STA. 49 + 52.20 L.A.	4952.20 L.A.
STA. 49 + 60.00 L.B. =	Equation **+** 7.80 =	**+** 7.80 =
STA. 49 + 52.20 L.A	STA. 49 + 60.00 **L.B.**	4960.00 **L.B.**

REMEMBER:

Subtract a minus equation from line ahead to equal line back.

Consider this MINUS equation. Equation = - 2.50
STA. 28 + 40.50 L.B. =
STA. 28 + 43.00 L.A.

Solve these Equations.

a. Equation = _____
STA. 361 + 81.00 L.B. =
STA. 361 + 41.56 L.A.

b. Equation = _____
STA. 236 + 15.50 L.B. =
STA. 237 + 08.50 L.A.

2-50. *(continued)*

Fill in the blank with the correct answer by solving for the unknown in each of the following equations. Show your work. Refer often to the examples.

c. Equation = _____
STA. 01 + 20.40 L.B. =
STA. 01 + 23.20 L.A.

d. Equation = + 2.00
STA. 40 + 82.00 L.B. =
STA. _____ L.A.

e. Equation = - 1.20
STA. _____ L.B. =
STA. 94 + 62.04 L.A.

f. Equation = _____
STA. 61 + 52.05 L.B. =
STA. 61 + 32.05 L.A.

g. Equation = - 5.67
STA. 52 + 60.30 L.B. =
STA. _____ L.A.

h. Equation = + 2.53
STA. _____ L.B. =
STA. 25 + 34.56 L.A.

LAYOUT MAPS

2-51. LAYOUT MAPS include:

- A station number indicating each project beginning,
- A station number indicating each project end,
- Equations for each project.

*With this information, calculating the length of a project is possible.

Review the table below. It shows the length of the project (SITE NO. 1) from **Sheet 1, DRAIN CANAL BRIDGES, STATE PROJECT H. 000238.**

	Station Number	**PROJECT LENGTH**
End SITE NO. 1 (look left of the layout map)	STA. 119 + 97.89	11997.89′
Begin SITE NO. 1 (look top left of the layout map)	STA. 101 + 62.11	10162.11′
Find the difference: SUBTRACT begin from end		1835.78′
Equation (none noted)	0′	0′
Since there is no equation		1835.78′

2-52. Occasionally several equations are involved a single project. Remember, an equation may be either “PLUS” or “MINUS.”

To find the project length, subtract the beginning station from the ending station, then, add, or subtract the algebraic sum from the result.

For example, consider a project with a beginning station number of 10 + 00 and an ending station number of 240 + 24. With equations of + .91, - 2.22, + 5.23 and - 10.50.

Compute the project length as follows:

Ending station	24024′
Beginning station	1000′
Difference	23024′

Add all PLUS and MINUS equations like this.

+ .91	- 2.22
+5.23	-10.50
+6.14	- 12.72

SUBTRACT the smaller figure from the larger, like this: - 12.72

+ 6.14

AND give the sign of the larger number (-) 6.58

THIS IS AN ALGEBRAIC SUM

Since you have a minus 6.58 *(-6.58)* subtract it from 23024.00′

- 6.58′

Project Length = 23017.42′

2-53. On Sheet number 1, DRAIN CANAL BRIDGES ON U.S. 90, find the **LENGTH OF PROJECT** table located below the Layout Map in the bottom right corner of the sheet. Examine the following column headings.

- The **Description** column with the stations numbers associated with project.
- A column titled **Algebraic Sums of all Equations.**
- Gross length
- Exception
- Bridge Length (in feet and miles)
- Roadway Length (in feet and miles)
- Total Length of Bridges (in feet and miles)
- Total Length of Roadway (in feet and miles)

Complete the following statements using the information from the LENGTH OF PROJECT table.

a. The algebraic sum of all equations for H.000238 equals _____ feet.
b. The gross length for SITE NO. 1 is _____ feet.
c. The Exception length for STA. 119 + 97.69 to STA. 202 + 91.91 is_____.
(Note: The table differs from the layout map with regard to the End Site No.1 station number)
d. The bridge length between STA. 202 + 91.91 and STA. 217 + 90.51 is _____ miles.
e. The total length of roadway is _____ miles.

2-54. The Layout Map for DRAIN CANAL BRIDGES ON U.S. 90 shows the station numbers associated with two Bridge sites. Locate the eastern most BRIDGE SITE on the Layout Map. It is associated with STA. 210 + 02 and STA. 210 + 78.

Calculate the length of this bridge by subtracting the beginning station number from the ending station number.

STA. 210 + 78 minus STA. 210 + 02 = 210+78 or 21078′
- 210+02 -21002′
76′

(*although the title sheet reads - 77.50*′)

2-54. *(continued)*

a. Locate the western most BRIDGE SITE on the Layout Map. It is associated with STA. 110 + 08 and STA. 110 + 85.

Calculate the length of this bridge by subtracting the beginning station number from the ending station number. Show your work.

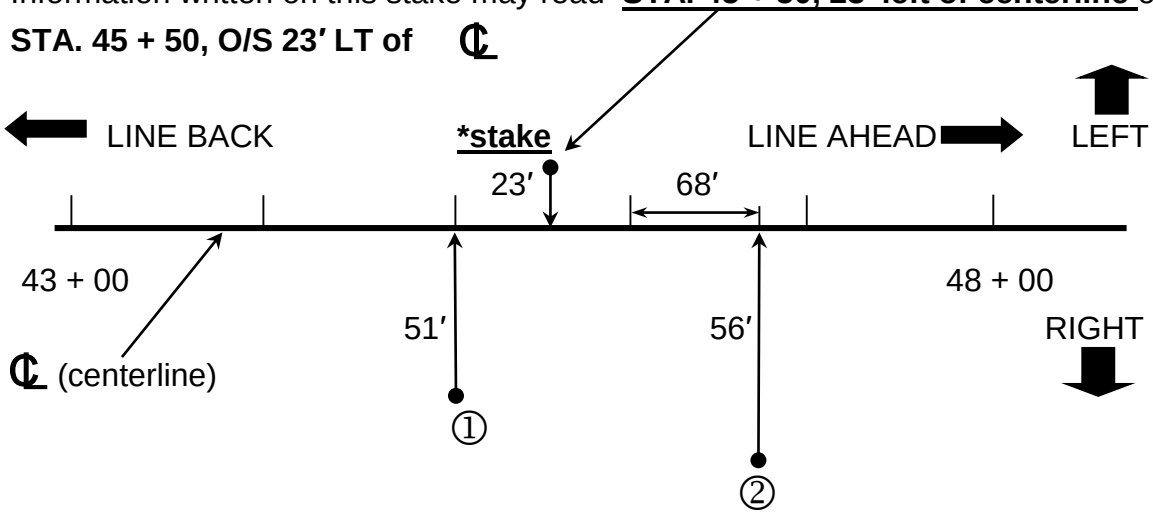
2-55. Wood **SURVEY STAKES** are driven in the ground along the centerline at station points. When construction starts, the stakes are repositioned, and placed alongside the proposed highway.

When relocating a stake, it is important to write **on the stake** the **DISTANCE moved (offset) from THE CENTER LINE**. Abbreviations are commonly used in order to write all the information on a stake. For example, **O/S** means, "offset."

Refer to the illustration below.

The stake referencing the station 45 + 50 was moved from the centerline to a position beside the construction work.

Information written on this stake may read **STA. 45 + 50, 23′ left of centerline** or **STA. 45 + 50, O/S 23′ LT of ℄**



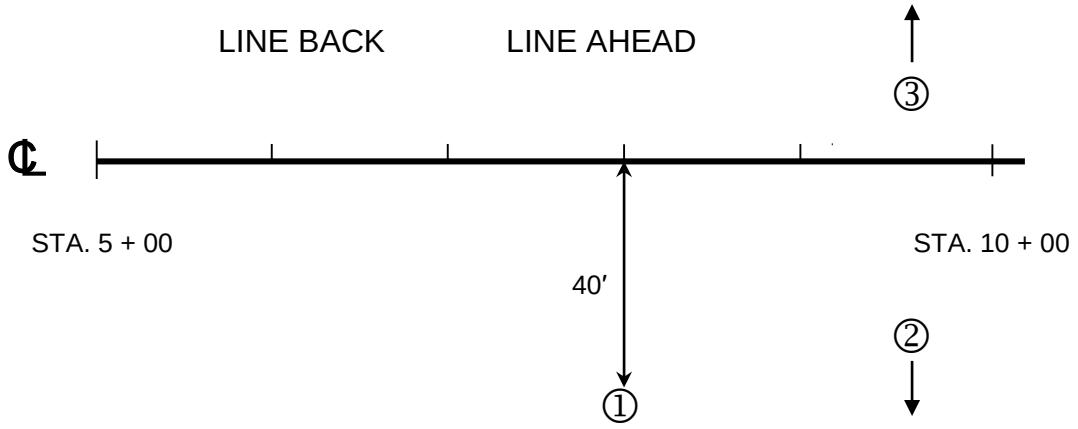
a. Moving stake ① fifty-one feet from the centerline requires writing the appropriate information on the stake. Record the information needed in the blank.

_____

b. Write the information needed on the stake located at point ②_____

2-56. **FILL IN THE BLANKS.**

Until you have completed this section, refrain from looking at any pages other than Sheet 1, DRAIN CANAL BRIDGES ON U.S. 90 in the Plan Book.



Refer to the drawing above. Complete the following.

a. Draw an arrow pointing in the direction of LINE AHEAD. _____

b. Draw an arrow pointing in the direction of LINE BACK. _____

c. Number ② indicates which side of the centerline (left/right). _____

d. Number ③ indicates which side of the centerline (left/right). _____

e. What information is written on the stake located at point ①? _____

2-57. Fill in the blanks below with the correct answer. Use the TITLE SHEET for H. 000238, Drain Canal Bridges on U.S. 90 to find the information.

a. Record the total miles of STATE PROJECT - H. 000238. _____

b. S.P. H. 000238 **SITE NO. 1** is between STA. _____ and STA. _____.

c. S.P. H. 000238 **SITE NO. 2** is between STA. _____ and STA. _____.

d. S.P. H. 000238 **SITE NO. 1** runs from the _____ to the _____. (Direction)

e. S.P. H. 000238 **SITE NO. 2** runs from the _____ to the _____. (Direction)

f. What is the TOTAL MILES OF **BRIDGES** FOR S.P. H. 000238_____

g. This project is located in _____ Parish.

Note:

If you missed MORE than three questions, turn back to page 2-23 and read parts 40 through 55. If you missed three questions or LESS, correct any wrong answers and continue with Chapter Two.

SURVEY DATA

A survey starts from a permanent **BENCH MARK**, a vertical and horizontal reference point. Coordinate systems establish and reference the data at this starting point. Listed below are acronyms, proper names, and coordinate systems.

- **L.G.S.** - LOUISIANA GEODETIC SURVEY.
- **U.S.C. & G.S.** - UNITED STATES COAST and GEODETIC SURVEY.
- **Grid Bearings** are another STATE COORDINATE system.
- **DATUMS USED** - give a HORIZONTAL and VERTICAL reference point.

Find the SURVEY DATA in the bottom left corner of the Layout Map for the DRAIN CANAL BRIDGES ON U.S. 90 project.

Notice the acronym “N.G.V.D.,” it refers to the National Geodetic Vertical Datum of 1929. For most of the 20th Century, surveyors and engineers used this system for relating ground and flood elevations. The more accurate North American Vertical Datum of 1988 (NAVD 88) replaced it.

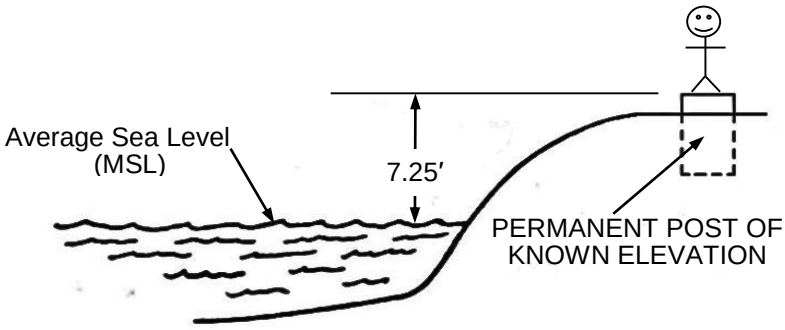
2-58. Surveys reference **horizontal** and **vertical points**.

ELEVATIONS identify the position of Vertical points,
while PLAN views identify the position of Horizontal points.

2-58. SURVEY DATA *(continued)*

ELEVATION is the height of a permanent object (monument) above average *(mean)* sea level.

In the illustration to the right, the elevation marker is a post driven into the ground.



Notice the 6′ tall person standing on the post in the above drawing. Here is how to calculate the elevation at the top of the individual's head.

Start by writing down the MSL.

7.25′ (height of permanent marker above sea level)

add **6.0′** (the height of the person)

this equals an elevation of **13.25′** feet at the top of our example's head.

2-59. Surveyors record elevation (vertical) information in a ledger called a "**LEVEL BOOK**." Title Sheets in a plan set reference the surveyor's LEVEL BOOK(s).

Look under the Layout Map on sheet 1- DRAIN CANAL BRIDGES ON U.S. 90, locate at the survey data.

Record the LEVEL BOOKS used for the project.

a. _____

Fill in the blanks provided with the correct phrase or word.

b._____refers to the height of a permanent object above average (mean) sea level.

c. _____ is a permanent object depicting a known elevation.

d. ELEVATIONS identify the position of _____ points.

2-60. **Level** and **Transit** books contain survey data. They are the **original source books** of data for a given project.

- **LEVEL books** contain Elevation data (vertical information)
- **TRANSIT books contain** Horizontal data (plan information.)

These books are recorded on the Title Sheet near (beneath) the Layout Map.

Special Note
If suspected errors occur, always check the original source books.

Fill in the blank provided with the correct phrase or word.

a. _____ books record Horizontal data.

b. _____ books record Vertical data.

Note: *Remember… it is important to understand how sheets within a plan set relate to each other. While the Title Sheet provides general facts, other plan sheets provide detailed material.*

For example, ***additional Survey*** *related material (magnetic variation and bearing data) appear on sheets along with the "Right-of-Way" details.*
Similarly, various "scales" (scale factors) appear on other plan sheets, e.g., Plan and Profile sheets. Other chapters in this course explore these topics.

TRAFFIC DATA, REVISIONS, AND APPROVALS

Highways are designed to solve traffic problems. Defining the problem is only the first step. There is little point in building or improving a project to solve a traffic problem today, only to see it become obsolete and outdated too soon after it is started. Anticipating problems, then designing features into the project to help solve them, is vital to a successful outcome.

To help overcome being "outdated," surveys of present day traffic generate an estimate of future traffic load, sometimes, as much as 20 years in advance.
These estimates aid in designing a practical and useful road.

The **TRAFFIC DATA** information is located in the lower left corner of the DRAIN CANAL BRIDGES ON U.S. 90 Title Sheet, above the SCHEDULE OF REVISIONS.

Recorded below is the **Traffic Data** taken from the Title sheet of DRAIN CANAL BRIDGES ON U.S. 90.

TRAFFIC DATA
2011 A.D.T. = 33,600
2031 A.D.T. = 46,900
D = 55%
K = 10%
T = 11%

SITE NO. 1
DESIGN SPEED = 55 M.P.H.
DESIGN CLASS = UA – 4

SITE NO. 2
DESIGN SPEED = 45 M.P.H.
DESIGN CLASS = UA – 2

2-61. Here is how to interpret **the TRAFFIC DATA information**.

- The highway indicated on the title sheet DRAIN CANAL BRIDGES ON U.S. 90 is designed to handle the estimated traffic flow in the year 2031.
- The **Average Daily Traffic (A.D.T.)** in 2011 is 33,600 vehicles.
- Designers estimate **in the year 2031**, the A.D.T. will be 46,900 vehicles.
- The **directional distribution of traffic flow (D)** is estimated at 55% during the design hour. This is stated as a percentage of the design hourly volume.
- The **design hourly volume (K)** is expressed as a percentage of the 2031 projected A.D.T.
- **T** is the number of trucks and buses expressed as a percentage of the design hourly volume.

Refer to the *DRAIN CANAL BRIDGES ON U.S. 90* **TRAFFIC DATA** from the previous page or the Title Sheet to answer the following questions.

a. Where (on the Title sheet) is the location of the Traffic Data information?
_____

b. What percentage of the design hourly volume consists of trucks and buses?
_____, represented with which letter? _____

c. The design hourly volume of traffic is _____ percent of the 2031 _____.

d. What is the directional distribution percentage of traffic flow during the design hour? _____

REVISIONS

It is necessary from time to time to make changes to a plan sheet; however, only one person can authorize a change to an approved plan sheet, the Chief Engineer. The Project Engineer submits potential changes through a "chain-of-command" for approval. Even after the potential changes obtain the proper "chain-of-command" approval; it is up to the Chief Engineer to sign the change order.

When master sheets are changed, notations concerning the changes are recorded in the **revision block** of the master. Reproduction of new master sheets take place, and copies are distributed to those in possession of plan sets, who, in turn destroy the old sheets.

2-62. The **SCHEDULE OF REVISIONS** block is located in the lower left corner of the DRAIN CANAL BRIDGES ON U.S. 90 Title Sheet. This revision block applies to all sheets in the set of plans. There also is a revision block on each individual sheet, which applies to that particular sheet. Signatures on the right side of the Title Sheet tell when the original set of plans was approved, while the revision block indicates appropriate revision information. A signature and professional engineering seal is also required on each sheet.

a. Has the Chief Engineer approved this set of "DRAIN CANAL BRIDGES ON U.S. 90" plans? _____

b. Were the plans revised or altered after final approval? _____

c. Record the sheet number, and the location of the Schedule of Revisions Block.

_____

2-63. **Use the Title Sheet, Sheet 1, for the I-12 – DUMPLIN CREEK project** found in the Highway Plan Book to answer the following questions.

a. Has the Chief Engineer approved this set of "I-12 – DUMPLIN CREEK" plans?_____

b. Is the signature of the chief engineer on the plan? _____

c. How many times were these plans revised (according to the Revision Block?)

_____

d. List the sheet numbers affected by each revision._____

e. Can a Project Engineer approve plan set changes? _____

INDEX TO SHEETS

Located in the upper left corner of the Title Sheet is the **INDEX TO SHEETS**, it is similar to the Table of Contents found in a book. When there is not enough space on the Title Sheet, the **INDEX TO SHEETS** is placed on the next sheet, Sheet 1a.

2-64. Index to Sheets "facts:"

- The Title Sheet is numbered "Sheet 1" in a plan set.
- Typical Section and Details Sheets are numbered: 2, 2a, 2b, etc.
- Summary Sheets, with the exception of bridge summaries, are numbered: 3, 3a, 3b, etc.
- Bridge summaries are included with the Bridge Sheets.

Use the Title Sheet, Sheet 1 for the DRAIN CANAL BRIDGES ON U.S. 90 project to answer the following questions with regard to the **INDEX TO SHEETS**.

a. List the sheet numbers for the Embankment Widening Detail Sheets associated with this project. _____

b. List the sheet numbers for the Plan and Profile Sheets in this project. _____

c. The _____ is on occasion referred to as the Table of Contents for a set of plans.

d. List the sheet numbers for Summary Sheets associated with this project. _____

e. Generally, the index is located in the upper left corner of the _____.

f. On what sheet numbers will you find the Bridge Plan Sheets? _____

g. List the sheet numbers for Cross-Section Sheets _____ (do not include the other sheets that contain cross-sections)

h. List the total number of sheets (include cross-section information.)_____

i. If there is insufficient space for an INDEX TO SHEETS on Sheet 1, where will it be relocated? _____

j. Does the INDEX refer to any RIGHT OF WAY MAPS? _____ If so, what are the sheet numbers? _____

k. List the sheet numbers for the Typical Sections and Detail Sheet(s) associated with this project. _____

2-65. **Use the Title Sheet, Sheet 1 for the I-12 – DUMPLIN CREEK project** located in the Highway Plans Book to answer the following questions with regard to the **INDEX TO SHEETS** index.

a. What are the sheet numbers containing Plan and Profile information?

_____

b. What are the sheet numbers for **Cross-Section** Sheets _____
(*do not include the sheets that contain cross-sections*)

c. What is a valid reason for placing the INDEX TO SHEETS on Sheet 1A?

_____

d. Which sheets contain the Summary information? _____

e. Which sheets are Bridge Plan Sheets _____

f. The _____ is similar to a book's table of contents.

g. What are the sheet numbers for Summary of Drainage of Structure?

_____

h. Common placement of the index is _____ of the Title Sheet.

i. Which sheets contain the RIGHT OF WAY MAPS? _____

j. What are the sheet numbers for the Standard Plan Sheets? _____

k. What are the sheet numbers for the Signalization information? _____

CHAPTER TWO FINAL REVIEW QUESTIONS

Refer to the DRAIN CANAL BRIDGES ON U.S. 90 Title Sheet, carefully look it over to answer the questions in this section.

Refrain from checking the answer key until all the questions have been answered.

a. What type of highway is U.S. 90? (Interstate, United States, State)

_____

b. Record the State project number. _____

c. What is the total length of Bridges for this project? _____ (feet)

d. Which direction is this State Project heading? _____ (e.g. N to S, W to E)

e. The total length of the entire project is _____ miles.

f. What are the sheet numbers containing Plan and Profile information? _____

g. The bridge between stations STA. 101+62.11 and STA. 119 + 97.89 will be _____ feet long.

h. What is the station number of the END SITE N.O. 1? _____

i. What is the average daily traffic expected in the year 2031 on U.S. 90? _____

j. How many new bridge(s) are in the projects? _____

k. Record the Parish of this this project. _____

l. How many sheets contain Cross-Sections? _____

m. What is the design speed associated with STA. 217 + 90.51? _____

n. Is there a space dedicated for a Federal Project number in the Title block?_____

o. Which direction does the North arrow point? _____ (left, right, up, down)

p. What is the scale of the layout map on the original full-size title sheet? _____

q. The Index to Sheets is on sheet number _____

r. What is the ending station number for SITE N.O. 2? _____

s. What station is associated with the **western** most end of this project? _____

t. Record the name of the unincorporated town close to this project._____

***Note**: Check your responses with the answer booklet. If you missed MORE than three questions, review this chapter again and correct any wrong answers before progressing to Chapter 3.*

TRAINING NOTES

TRAINING NOTES

CHAPTER 3
RIGHT-OF-WAY MAPS

INTRODUCTION

The primary purpose of a Right-of-Way Map is to identify parcels of land (property) slated for purchase for a given project. Right-of-Way sheets also include the size of land parcels adjacent to the proposed construction project, and they identify the name(s) of each property owner(s).

Right-of-Way Maps are **plan views** displaying the path of a highway construction project with relation to adjacent properties.

The index on Sheet 1 of the State Project H. 000238 *(Drain Canal Bridges on U.S. 90)* shows the absence of Right-of-Way sheets. Therefore, this chapter will reference the Right-of-Way sheets for State Project, I-12 – DUMPLIN CREEK.

The term “Right-of-Way” is abbreviated as R/W or ROW, and both are used throughout this chapter.

Open the Highway Plan Book, turn to the Title Sheet for the State Project I-12 – DUMPLIN CREEK, and find the Index to Sheets. Note that the R/W sheets for this project are 95-103; they are also in the Highway Plan Book. Review them before progressing.

R/W sheets for State Project I-12 – DUMPLIN CREEK depict the use of aerial-photographs “overlaid” with conventional drawings. **Drawn maps** use symbols to represent terrain information, whereas **aerial-photograph based maps** rely on visual references to identify terrain information. Previously, the department used aerial-photograph maps as the background on Right-of-Way maps; now drawn maps take precedence. Since basic map information and concepts are the same, these R/W sheets remain pertinent to this course.

Turn to Sheet 95. It is a Title Sheet for the R/W map. Notice that it resembles the Title Sheet for State Project I-12 – DUMPLIN CREEK. There are differences as well as two recognizable features, the **PROJECT CAPTION** and the **NORTH ARROW**.

Throughout the chapter, consecutive **TOPIC** numbers indicate various facets of information pertaining to Right-of-Way. Occasionally, topic numbers will reference one another.

Introduction *(continued)*

As in the previous chapter, there are review questions. Complete each question, as they will become useful study guide material.

R/W *(Right-of-Way)* SHEET FEATURES

3-1. Refer to the Title Sheet I-12 – DUMPLIN CREEK found in the Highway Plan Book. Fill in the blanks with the correct answer.

a. The _____ ____ _____ *(hint, 3 words)* indicates the sheet numbers of the Right-of-Way Maps in a plan set.
b. What are the sheet numbers for the Right-of-Way maps? _____
c. Two types of Right-of-Way sheets are _____ and _____ maps.
d. Right-of-Way Maps identify _____ neighboring the proposed construction project.
e. List two items that are on both the State Project Title sheet, and the Right-of-Way Title sheet. _____ and _____.

3-2. Notice the Title Sheet for the R/W is different from the title sheet for the entire plan set. In particular, the project numbers are different. Project numbers for Right-of-Way work differ from the construction project although they remain part of the project.

The identification box in the upper right hand corner refers to the original construction project. Note the project name, parish and route number remain the same.

3-3. Turn to Sheet 96; in the lower right corner of the sheet locate the R/W Title Block. It provides important information, such as:

- **the Name of the project (title)**
- **the R/W project number(s)**
- **the Parish and route number(s)**
- **the date of the completed R/W map**
- **the scale**
- **the R/W sheet number**

Notice that below the title box is a **File Number;** the project designers use this to locate original sheets. *(Sometimes it is cut-off the sheet, but check under the title blocks on other R/W sheets)*

3-3. *(continued)*

Fill in the blanks with the correct answer.

a. On sheet 96, _____ is located in the lower right corner.
b. Record the project name (title) _____
c. What scale is recorded on the R/W sheets? _____
d. If a full size sheet R/W sheet was reduced to a ½ size sheet, what would be the proportional scale?_____
e. Record the completion date for this R/W map _____
f. Sheet 96 is R/W Sheet number _____
g. Record the file number found under the R/W title block (box) _____

3-4. Locate the North arrow on sheet 96.
a. Which way is it pointing? (*Right, Left, Up, or Down*) _____.
b. The McDonald's Corporation property is located on the _____ (N,S,E,W) side of LA. 447.

LAND FEATURES – TOPOGRAPHY

Although the primary focus for Chapter 3 is Right-of-Way information, many details relating to the topography (land features) need review.

3-5. Sheet 96 (R/W sheet 1) illustrates the land from above in **PLAN VIEW**. Observe the trees located in the southwest corner (upper left) and in the east (bottom) of the sheet. Visible too are several buildings with outlined roofs. Ramps to Interstate 12, depicting the beginning of this project, appear at the south end of the sheet.

Sheet 96 is an aerial-photograph accompanied with an overlaid drawing. Refer to page 3-38 located at the end of this chapter, and review the various topography symbols used to represent land features.

Refer back to sheet 96. While difficult to see on this type of aerial-photograph drawing, notice what appear as "paths" (lighter areas) surrounding or leading from some of the buildings. These are driveways; they eventually join the highway. It is important that driveways remain in usable condition throughout the construction project.
Find sheet 403 (S.P. 268-01-0012) in the Highway Plan Book, then turn to the next sheet in the Plan Book, it is another copy of sheet 96. It clearly shows an example of a driveway joining the highway.

3-5. *(continued)*

a. Name the street crossing LA. 447 near the McDonald's Corporation property.

_____

At the top of sheet 96 there is information concerning townships and sections for this particular sheet. Two townships are shown; each has a corresponding section number.
Find Pendarvis Lane. It is the dividing line between the two townships. Notice at either end of Pendarvis Lane (east and west) the township information is again listed.

Above the township number(s) at the top of sheet 96 appear the words **Greensburg Land District**; indicating these townships are located in the Greensburg Land District.

Write the correct answer in the blanks

b. The township numbers are _____ and _____.
c. The corresponding section numbers are _____ and _____.

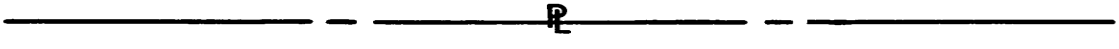
Note

"Property" can be personal property or real property. Most highway agencies refer to land as "real property" or "**parcels**."

Large parcels of land are measured in acres. Smaller parcels are measured in square feet. There are 43,560 square feet in an acre.

3-6. **Real property** is identified by the name of the owner.

- **Property lines** indicate property ownership limits.
- The symbol for property lines is shown in the Legend at the bottom-center of sheet 96.
- Below is the line and symbol used to depict a property line.



3-6. *(continued)*

Look at the center of sheet 96 along the west side of LA 447, Star Enterprise is the property owner. Locate the property lines shown on each side of this parcel.

Write the correct answer in the blanks.

a. Who owns the adjacent parcel south of this property? _____

b. Who owns the adjacent parcel north of this property? _____

3-7. Property lines surround each parcel, however, many times only those property lines of interest to right-of-way and construction work are shown.

a. For the three parcels mentioned in topic 3-6, the east property line is also the _____-_____-_____ line.

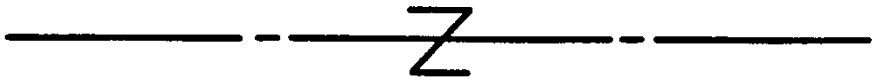
3-8. Recorded on sheet 96, within the property boundaries, is the property owner name. Locate the property in the northwest corner of the sheet. Talbot and Talbot, Inc., ET AL. own the property.

- Adding "**ET AL**." to the property owner name indicates "**and others**"

Talbot and Talbot, Incorporated, **and others** own this property.

- Other times adding "**ET UX.**" to a property owner name, indicates "**and wife**."

Occasionally, a symbol like this appears on a property line:



This symbol is a **LAND HOOK** indicating the same owner owns the property on both sides of the line. A good example of a land hook is found in the middle of sheet 100 (I-12, Dumplin Creek).

RIGHT-OF-WAY

3-9. Review the location of the proposed highway construction project on Sheet 96. Highway LA 447 runs from south to north (check the North arrow.) The contractor constructs the highway in the Right-of-Way. Right-of-Way gives (DOTD,) the "right" to pass over the property of others. **RIGHT-OF-WAY lines** indicate the

3-9. *(continued)*
limits or boundaries of the Right-of-Way. Review the definition of Right-of Way as it is written in Appendix A.

Locate the R/W lines on sheet 96. Although difficult to see, there are usually notations near them indicating the type of ROW line.

Here is an example of a Right-of-Way line: 

a. What is the abbreviation for Right-of-Way? _____

b. Place a check in the box next to the line depicting an R/W line.

☐ 

☐

3-10. Closely observe the R/W lines on Sheet 96. Notice some R/W lines are marked as **EXISTING R/W** and others **REQ'D R/W**.

- "EXISTING R/W" means the department already has the rights to use this property due to previous construction.
- "REQ'D R/W" indicates additional property is required for the current project.
- In some cases the EXISTING and REQ'D R/W lines are the same line, they are marked "EXISTING AND REQ'D R/W."

a. Will additional Right-of-Way be required for this new project? _____

3-11. When the Right-of-Way for an existing road is not enough for a new project, additional R/W is necessary. The department **purchases** the land between the existing R/W lines and the REQ'D R/W line.

3-12. A table in the lower left corner of sheet 96 indicates the **net area** (acres) of additional Right-of-Way the department anticipates purchasing from property owners. Written on the R/W map is the amount of land the reimbursed property owner continues to possess, it is abbreviated R.A (remaining land area.)

Note: if more space is needed, continuation of this table appears in the upper left corner of the R/W sheet.

3-12. *(continued)*

Refer to the table in the lower left corner of Sheet 96.

The department needs to purchase additional Right-of-Way from Star Enterprise. The net required area is 0.152 acres.

After the department purchases the 0.152 acres, how much land will Star Enterprise still possess? Look below the name on the property for this information.

R.A. = 1.320 acres

To find the amount of land previously owned by Star Enterprise, review the following.

NET REQ'D AREA		0.152 acres (information recorded in the table)
REMAINING AREA	+	1.320 acres (information written on the property)

Star Enterprise *previously* owned 1.472 acres

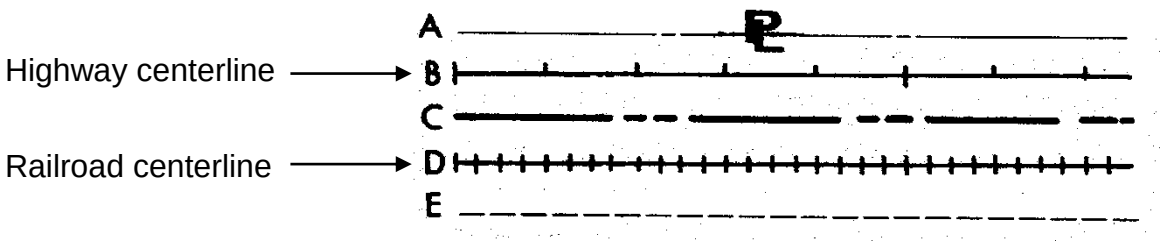
Write the correct answer in the blanks.

a. How many acres of Right-of-Way will the department purchase from McDonalds Corporation? _____

b. How much land will McDonalds possess **after** the purchase? _____

c. How much land did McDonalds own **prior** to the R/W purchase?_____

3-13. Another type of Right-of-Way is the **Railroad Right-of-Way**, abbreviated RR R/W. When the railroad is parallel to the highway, only one Right-of-Way line appears between the two if they are close enough together. This R/W line represents **common Right-of-Way**, put simply, DOTD, and the Railroad use the Right-of-Way.



3-13. *(continued)*

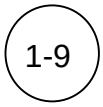
Write the correct answer in the blanks

a. Which line from the previous page represents **common Right-of-Way**: A, B, C, D, or E? _____

R/W PARCEL TYPES

3-14. The department requires different parcel types for a variety of purposes i.e. Right-of-Way, Drainage, Detour, Construction, etc.
All parcels have a symbol; it identifies the type of parcel needed by the department.

Below is an example of a symbol representing additional Right-of-Way for a new project. This parcel of land is between an existing R/W line and a required R/W line.



Parcel symbol

Numbers written in the Parcel symbols **include the R/W sheet number** (derived from the Title Block) **and the parcel number** from the same sheet.

Parcels numbers ordinarily run consecutively from left to right across each R/W sheet. Exceptions exist, as evidenced with parcels 1-12, 1-11, 1-13 on Sheet 96.

Occasionally a parcel on the right edge of an R/W sheet continues on the next R/W sheet. It retains the same parcel number on both sheets. For example, parcel 2-6 (sheet 2, parcel 6) continues on R/W Sheet 3. “2-6” is written in the Parcel Circle symbol on R/W sheets 2 and 3.

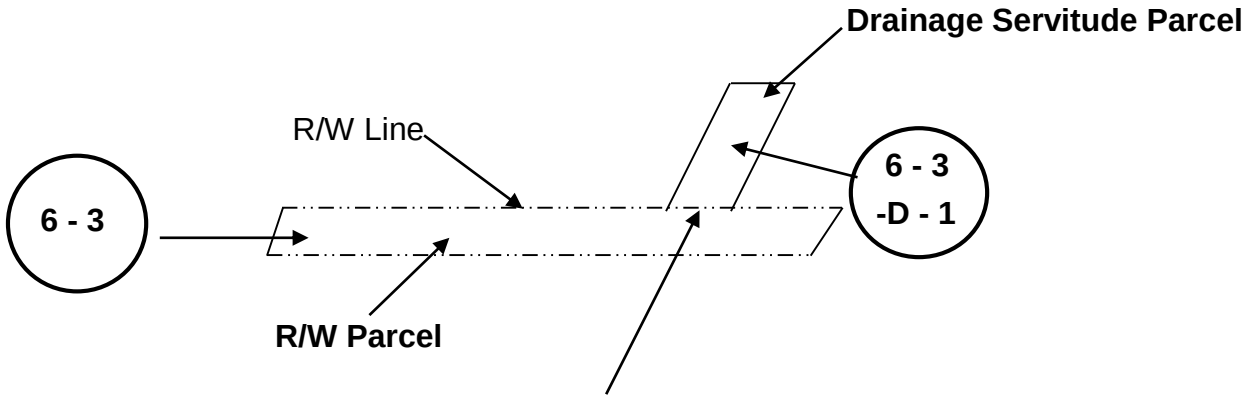
Certain circles (parcel symbols) are solid, while others are dashed. Solid circles (parcels) have designations listed in the table on that particular R/W sheet. Whereas dashed circles have designations on another R/W sheet.

Turn to sheet 97 (R/W sheet 2.) Locate the parcel symbol 1-8 on the southern end of the drawing. Surrounded with a dashed circle, parcel 1-8 is a continuation from R/W sheet 1. Turn back to R/W sheet 1 (sheet 96), review “parcel 1-8” data in the table.

3-14. *(continued)*

a. Draw the symbol for the 10th Right-of-Way parcel shown on R/W Sheet 4.

3-15. On occasion, the department requires a **DRAINAGE** SERVITUDE PARCEL to drain water away from a project. The State does not purchase this type of parcel. It obtains a "**drainage servitude**," which is **permission** from the owner or owners to use a specific parcel of their land for drainage purposes only. Drainage servitude parcels start at the Right-of-Way line and extend away from the project as illustrated below.

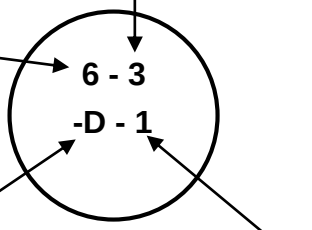


Notice the two parcels join at the Right-of-Way line. In this case, the first part of the drainage parcel number is the same as the Right-of-Way parcel (6 - 3.)

3-16. Here is the breakdown of the numbering system for a symbol representing a drainage servitude parcel.

This drainage servitude parcel connects to the **3rd Right-of-Way parcel** on **R/W Sheet 6**.

Both parcels (R/W & Drainage) are located on **R/W Sheet 6**.



D indicates drainage servitude parcel.

This is the **1st Drainage Servitude parcel** connected to Right-of-Way parcel 6-3.

> **NOTE:**
> **The ENTIRE number within the symbol (i.e. 6-3-D-1) is the <u>complete</u> Drainage Servitude Parcel number.**

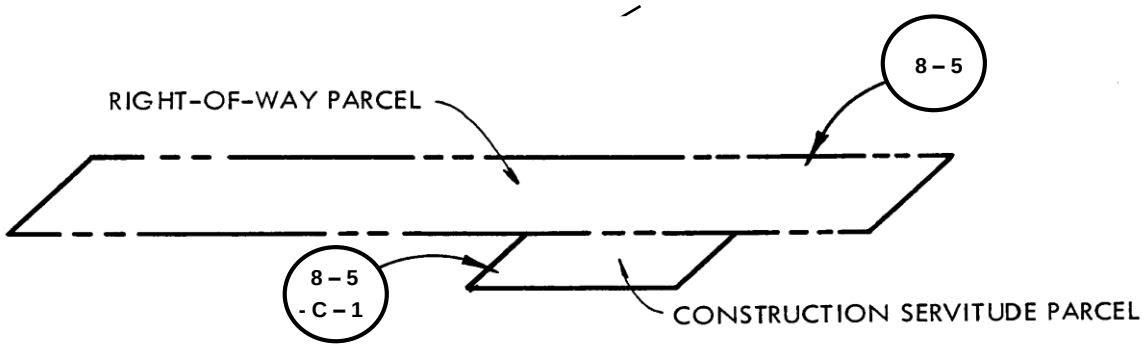
a. Draw a symbol with the appropriate numbers and letters associated with the 2nd drainage servitude parcel connected to the 4th R/W parcel shown on an R/W Sheet 5.

3-17. A **CONSTRUCTION SERVITUDE** parcel is similar in many ways to a drainage servitude parcel. Again, the department does not purchase this parcel; it obtains **permission** from the owner or owners to use a portion of their land for a specific purpose. Most often, construction servitudes serve as sites used for building a temporary detour during the highway project. One significant difference separates the two servitudes.

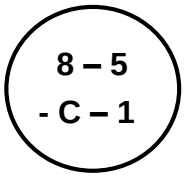
> **Drainage servitudes are usually at angles** to the Right-of-Way, whereas **construction servitudes are typically parallel** to the Right-of-Way.

See the illustration on the next page.

3-17. *(continued)*



The notation descriptors contained in a **Construction Servitude** parcel symbol are similar to the notations of a drainage parcel symbol. They are listed below.



- "**8**", represents the **R/W sheet,**
- "**5**" represents the **5th R/W parcel** (on sheet 8,)
- "**C**" ***indicates a construction servitude parcel***,
- the number **1** indicates this is the **first construction** servitude parcel associated with parcel 8-5.

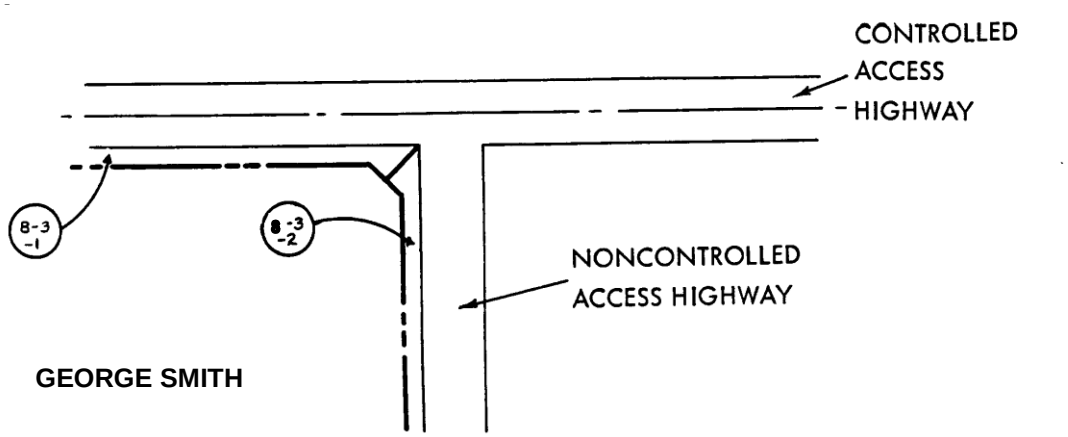
a. Draw a symbol with the appropriate numbers and letters identifying the 2nd construction servitude associated with the 6th Right-of-Way parcel shown on R/W Sheet 4.

3-18. At times, the department requires access to real property beyond the new R/W. An example of this would be, building a drainage catch basin on adjacent property while doing a subsurface drainage project. If this construction benefits the owner, the department secures a **RIGHT-OF-ENTRY agreement** from the landowner to perform the work. This provides a solution to a problem caused by road or bridge construction without the need to purchase property or to obtain ACCESS RIGHTS.

3-19. Certain highways have **controlled access**, meaning the property owners cannot build driveways or roads connecting to the highway except where designated by the department.

The illustration and notes shown below further define **controlled and non-controlled access**.

Notice that George Smith's property is contiguous (next to) to a controlled and a non-controlled highway.



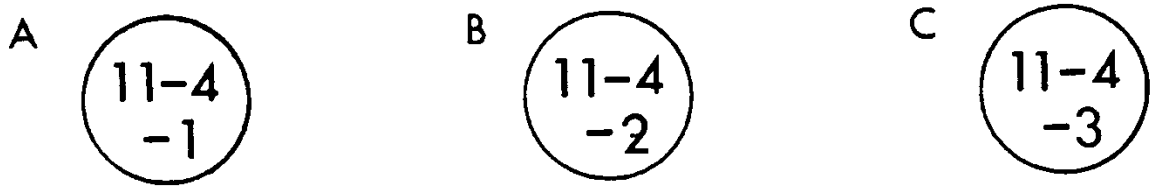
- The addition of the "**1**" after the R/W sheet and parcel number, (e.g. 8-3-**1**) indicates a R/W parcel adjacent to the controlled access highway. Inclusion of the number **1 designates controlled access**. Sometimes this parcel is referred to as the "*master parcel*."

- R/W Parcel 8-3-2 is adjacent to the non-controlled access highway. We know this because a "**2**" (or 3, etc.) follows the R/W sheet and parcel number.

a. Mr. Smith wants to build a driveway accessing a highway, which parcel **does not** have restrictions on driveway placement? _____

3-19. *(continued)*

b. Which of these parcels is the master parcel (controlled access?) _____



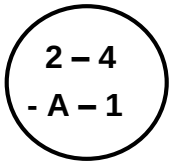
Parcel Symbol Letter designations. Complete the phrases, write the correct letter in the blank.

c. The letter **C** designates a _____ servitude parcel.

d. The letter **D** designates a _____ servitude parcel.

3-20. Examples of symbols representing **<u>Additional</u> and <u>Revised</u> acquisition parcels**

For example: the department purchased parcel 2-4 and then learns additional land is required from the same owner, the additional parcel is marked with the same parcel number, 2-4, followed with "**A**," indicating the parcel is an **ADDITIONAL ACQUISITION**.



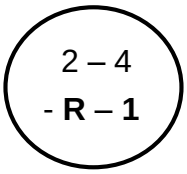
- Following the "**A**" is the extension "**1**" indicating this is the **<u>first</u> additional acquisition** from this owner.

3-20. *(continued)*

Occasionally, mistakes happen when drawing a parcel in a plan set. Correcting the mistake requires issuance of a plan revision.

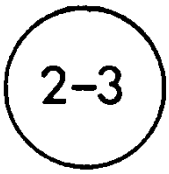
For example, a "drawing mistake" occurred with R/W parcel "2-4." The corrected plan sheet will reflect a new number assigned to the R/W parcel, changing it to "2-4-**R-1.**"

The R/W parcel number is 2 – 4, "**R**" indicates a revised parcel, and the "**1**" indicates this is the first revision of this parcel



Additional acquisition parcels, **revised** parcels, **controlled access** parcels and **non-controlled access** parcels ***are all forms of*** **Right-of-Way parcels.**

3-21. Interpret and identify the following Right-of-Way parcel symbols and **write the correct answer in the blank.**



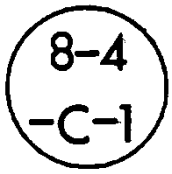
a. What type of parcel is 2-3? _____

b. What is the intended use for Parcel 2-3? _____

c. Parcel 2-3 is the _____ parcel on R/W sheet _____

d. What is the intended use for Parcel 2-4-D-1?_____

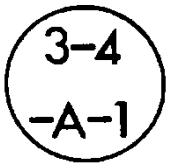
e. Found on R/W sheet _____, 2-4-D-1 is the _____*(hint -number)* _____ *(hint-type, 2 words)* associated with parcel 2-4



f. What is the intended use for Parcel 8-4-C-1?_____

g. Found on R/W sheet _____, 8-4-C-1 is the _____ *(hint -number)* _____ *(hint-type, 2 words)* associated with parcel 8-4.

3-21. *(continued)*

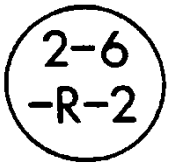


h. What is the intended use for Parcel 3-4-A-1?_____

i. Found on R/W sheet _____, 3-4-A-1 is the

_____ *(hint number)*_____

(hint-type, 5 words) associated with parcel 3-4.



j. What is the intended use for Parcel 2-6-R-2?_____

k. Found on R/W sheet _____, 2-6-R-2 is the

_____ *(hint - number)* _____

(hint-type, 4 words) associated with parcel 2-6.

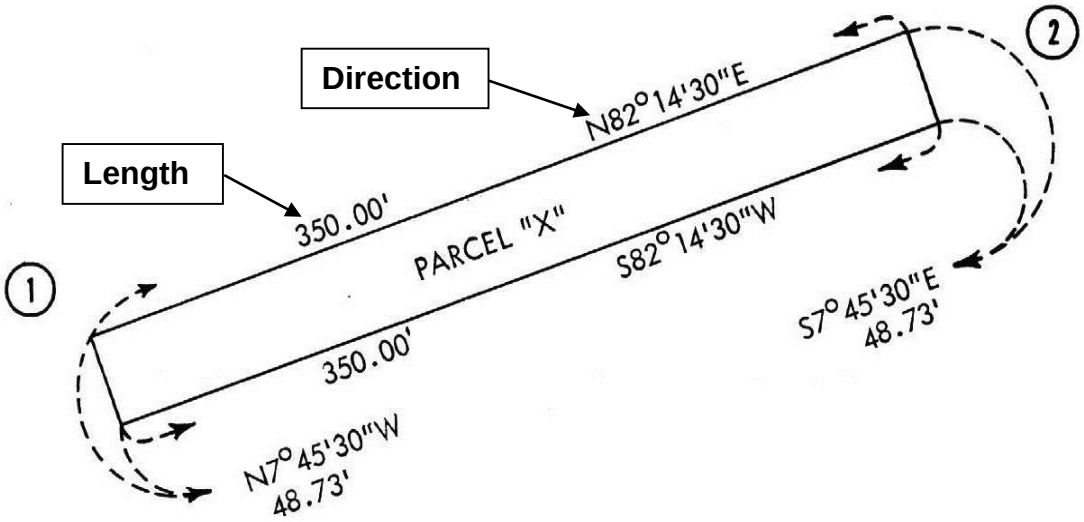
*Remember, the PARCEL NUMBER **is** the **ENTIRE** number found within the symbol,

e.g. 2-3-D-1 **is the complete** Drainage Servitude Parcel number.

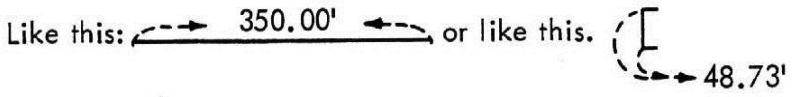
. PARCEL DIMENSIONS - How Parcels are Measured.

3-22. In the sample drawing below, notice parcel "X," has four sides, the two longest sides have the same dimension, 350´. Although probable, this is not always the case, as all four sides may have different lengths. Surveyors measure and record dimensions similar to those seen on each side on Parcel "X."

Two important items accompany the line representing the side of the parcel, **length, and direction**.



- Drawn below are two of the many ways used to represent the **dimension (length)** of a parcel side. Notice the "curved" dimension line with arrowheads.



- The dashed lines indicate the terminal (end) points of the line, and the arrowheads point to the overall length of the line.

- It is important to read the number ***AND*** the unit of measurement with regard to the length of the line.

  For example, read 48.73′ as *"forty-eight **point** seven three feet."*

BEARINGS

3-23. Refer to the illustration from the previous page. Accompanying the dimension (length) is a number-letter combination. This number-letter combination is the **BEARING**, **indicating the angular direction** of the line to another point or landmark.

N 82° 14′ 30" E

- The **first letter of a bearing** is either N (for north) or S (for south,) and the **last letter is either** E (for east) or W (for west).

- The number between the letters is the **bearing angle** measured in **degrees** (00°) **minutes** (00′) and **seconds** (00").

- Notice the sign for minutes is the same as the sign for feet (′) and the sign for seconds is the same sign used to indicate inches (").

For instance, when describing the BEARING, N 82° 14′ 30" E, we read, **NORTH, 82 degrees, 14 minutes, 30 seconds, EAST.**

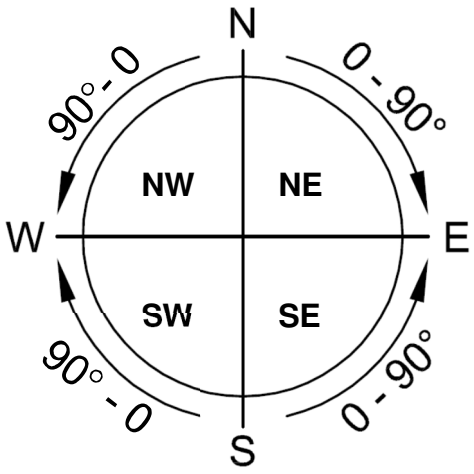
Note:

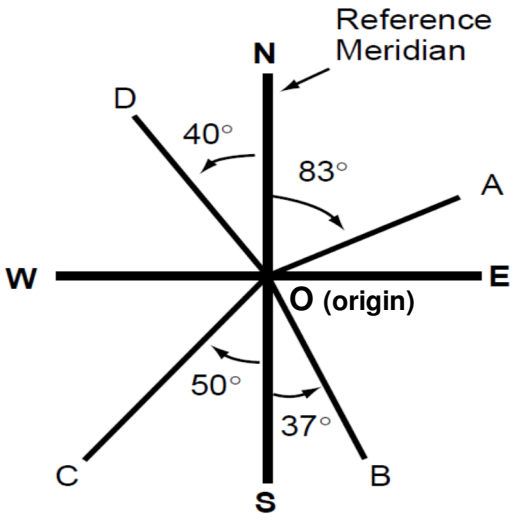
There are 360° degrees in a circle, 60 minutes in a degree, and 60 seconds in a minute.

* A one-second angle is 1/60th as large as a one-minute angle, which is 1/60th as large as a one-degree angle.

3-24. BEARINGS AS DIRECTIONS

- Look at the illustration on the left below, find the “compass” points (N,S,E,W) on the circle, and the 0 – 90° in each “quadrant.”
- Now look at the illustration on the right, **find the line segment OA**, it is located in the upper-right or North-East (NE) quadrant.
- To determine the bearing of line OA: start at the “**N**,” **travel clockwise** around the circle toward “**E**” (east) stopping at 83 degrees.
- Line segment OA has a bearing of **N 83° 00′ 00" E**.





- Likewise, **observe line segment OD** located in the upper-left (NW) quadrant.

- To determine the bearing of line OD: start at the “N” (south,) **travel counter-clockwise** around the circle toward “W” (west) stopping at 40 degrees.

- Line segment OD has a Bearing of **N 40° 00′ 00" W** *(North, 40 degrees, zero minutes, zero seconds, West)*

3-24. *(continued)*

Using the diagram(s) and information from page 3-18, fill in the blanks with the correct information.

a. BEARING S 37° 00′ 00" E is associated with line segment _____.
The “S” and “E” indicate the bearing is located in the _____ quadrant. Start at the “S,” travel _____ around the circle toward _____ (N,S,E,W) stopping at _____ degrees.
Line OB has a Bearing of _____.

b. BEARING S 50° 00′ 00" W is associated with line segment _____.
The “S” and “W” indicate the bearing is located in the _____ quadrant. Start at the “S,” travel _____ around the circle toward _____ (N,S,E,W) stopping at _____ degrees.
Line OC has a Bearing of _____.

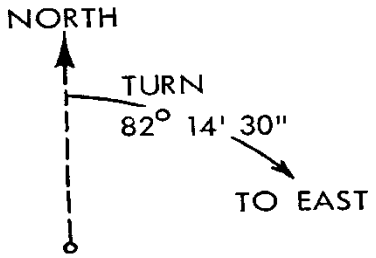
3-24. *(continued)*

BEARINGS allow the plan reader to find the **angular direction** of the line representing each parcel side.

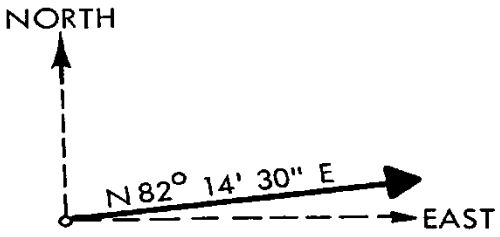
Follow these steps to orient the line direction N 82° 14′ 30" E.

Step 1 - Face NORTH (N) - zero degrees

Step 2 - Turn to the EAST (E) at an angle of: 82° 14′ 30"



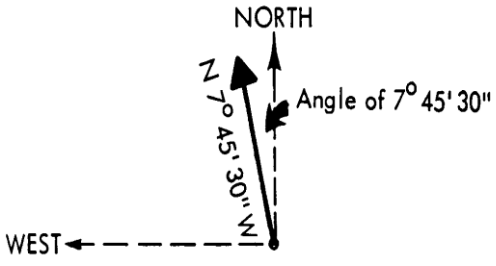
Step 3 - The solid line is the direction of the line representing the side of the parcel, pointing along a bearing of N 82° 14′ 30" E.



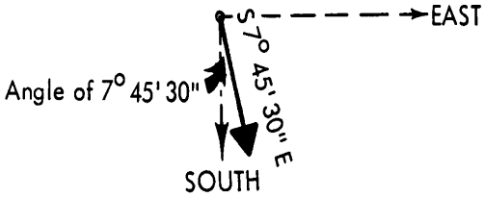
3-24. *(continued)*

Use the same process to locate these bearing headings.

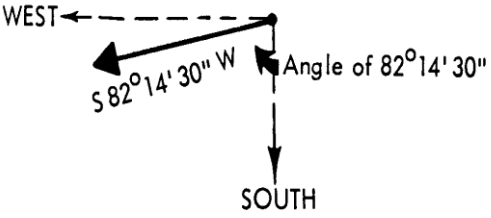
N 7° 45′ 30" W



S 7° 45′ 30" E

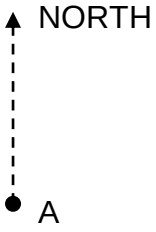


S 82° 14′ 30" W

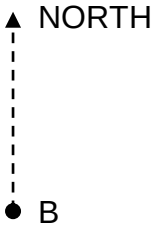


3-25. Given a point as the origin, draw a line approximating each bearing direction.

a. **N 30° 00′ 00" W** from point A

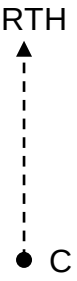


b. **N 60° 00′ 00" E** from point B

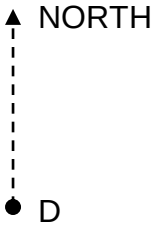


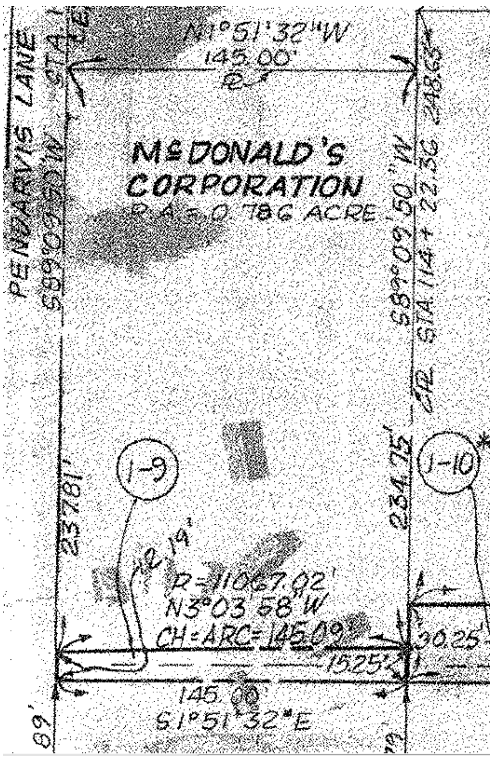
3-25. *(continued)*

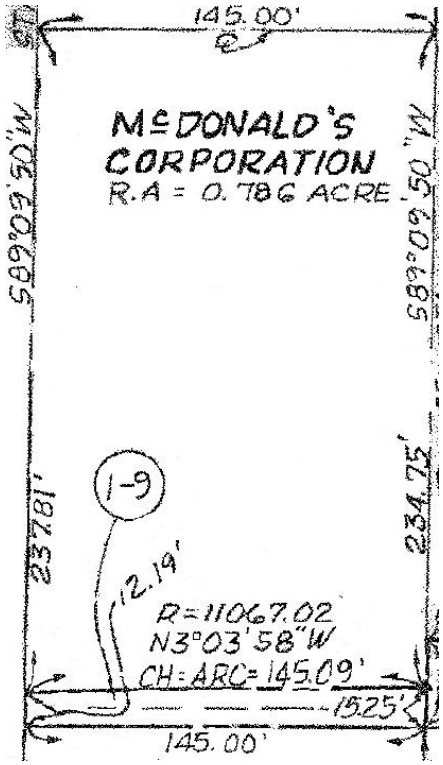
c. **S 45° 00′ 00" W** from point C



d. **S 30° 00′ 00" E** from point D







3-26. The illustration on the left is an exact copy of the McDonald's parcel and parcel 1-9 as it appears on sheet 96. Notice that the superimposed aerial-photograph has made the notes and dimensions around the parcel difficult to read.
The illustration on the right is the same, only it has had the background aerial-photograph removed. Because it is a magnified view of the parcels, it is somewhat blurred, however; the notes and dimensions are readable.

Locate parcel 1-9 on Sheet 96, it is Sheet 1 of the R/W plans.

Record the length and bearing of each side. A magnifying glass helps to see the dimensions. Read the hint.

a. North side: length _____
b. bearing _____

c. South side: length _____
d. bearing _____

e. West side: length _____
f. bearing _____

g. East side: length _____
h. bearing _____

> ***Hint:***
> *The north and south property line bearings for "McDonald's are the same as Parcel 1-9*

3-27. Refer again to parcel 1-9 on sheet 96. Using the magnified illustrations on the previous page and sheet 96, locate the dimensions specifying the distance from the centerline of LA 447 to the R/W lines on either side of LA 447.

a. What is the distance from the centerline of La 447 to the *required* R/W line along the west side of parcel 1-4? _____

b. What is the distance from the *required* R/W line of parcel 1-4 to the *required* R/W line of parcel 1-6? _____

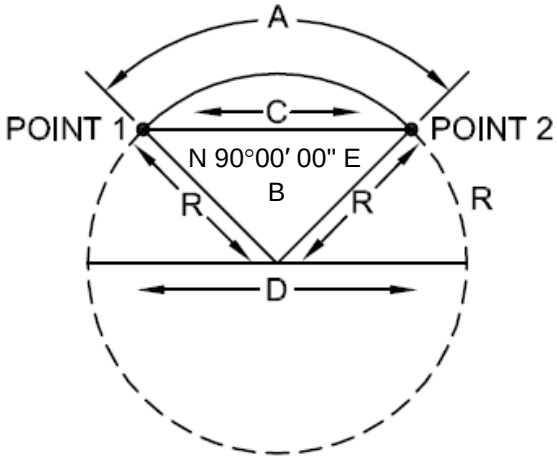
3-28. Examine the R/W parcels on either side of LA 447; observe the "dashed" **LIMITS OF CONSTRUCTION LINE** passing close to the middle of each R/W parcel, paralleling the R/W lines.

All construction work associated with the highway project occurs within the **limits of construction** lines. This allows the contractor sufficient room to operate.

CURVED R/W LINES

3-29. Previous topics dealt with length and bearing of "straight" property lines.
Curved R/W lines are a little more complex.
Right-of-Way lines are either straight or curved lines.

An example of "**CURVE DATA**" is located at the North end of the property owned by TALBOT AND TALBOT, INC, ET AL on sheet 96. The curve data refers to the slight curve appearing on the R/W line of R/W parcel 1-8.



Curves are **ARCS**, portions of a circle.

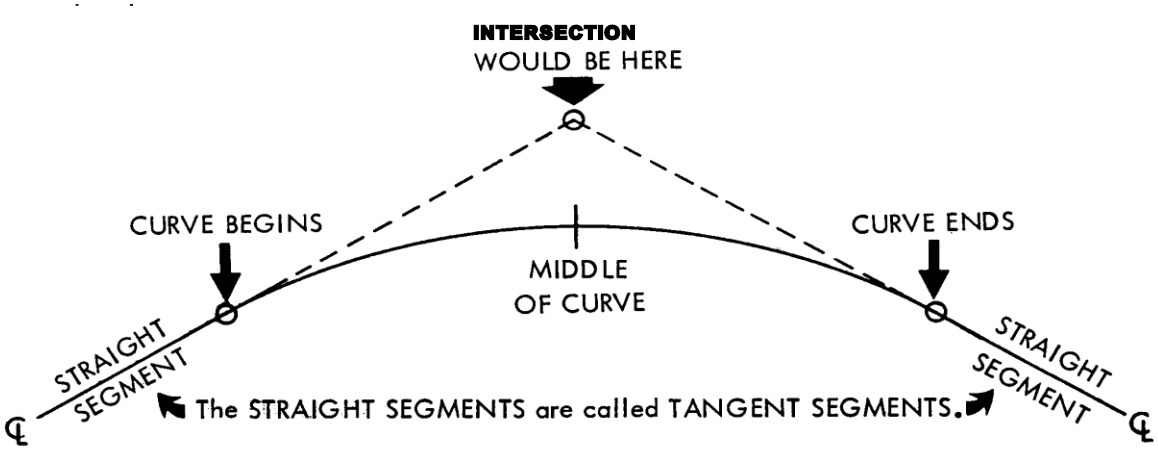
Study the information on the diagram.
A circle has several parts, **radius (R), arc length (A), diameter (D), chord length (C), and chord bearing (B)**.

3-29. *(continued)* **Refer to the drawing from the previous page**

- "**A**" is the **Arc Length,** the portion of the circle between Point 1 and Point 2. .
- "**C**" is the **Chord Length**, a straight-line distance between Points 1 and 2.
- "**B**" is the **Chord Bearing** (direction) of the line from point 1 to point 2. (N 90 °00′ 00" E)
- The distance from the center of the circle to Point 1 is **R**, the **Radius**. It is the distance from the center of the circle to Point 2.
- A straight line (**D**) drawn through the center of the circle is the **Diameter** or distance across the circle.

3-30. <u>CURVE DATA Basics</u>

Highways are combinations of straight and curved segments of roadway. During construction of a CURVED highway segment, the beginning and end of the CURVE are marked on the centerline. Below is a drawing depicting "straight" line segments (tangent segments) before the curve starts and after the curve ends. An intersection forms when these two lines extend beyond the curve (dashed lines.)



Shown above is a curve turning to the right, as evidenced by the beginning and ending points. Note the centerline is on the right side of the "intersection" during a "right" turning curve, and conversely, the centerline is on the left side of the "intersection" during the construction of a curve turning left.

During actual construction, markers indicate the curve beginning and ending points, as well as the "intersection." Across from the MIDDLE of the curve, the "intersection" is off to one side of the centerline.

3-30. *(continued)*

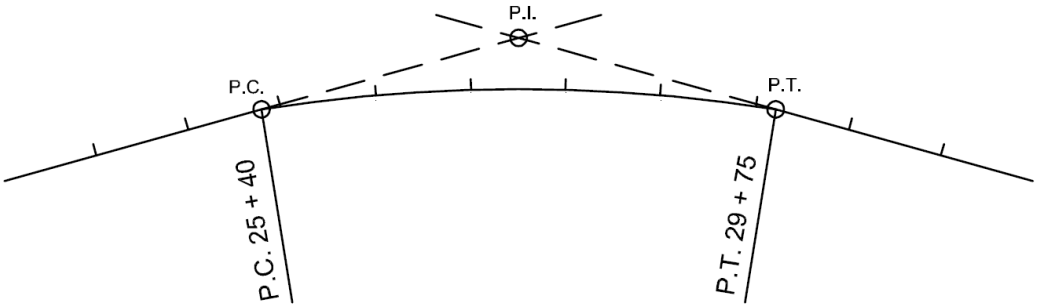
Answer the following questions, write the correct answer in the blank.

a. _____ is another term applied to a “straight segments.”

b. Consider a curve turning left; the “intersection” point is on the _____ side of the centerline. (left or right)

c. Consider a curve turning right, the “intersection” point is on the _____ side of the centerline. (left or right)

3-31. CURVE DATA - Abbreviations and Symbols



Plans show curve data with a combination of abbreviations and symbols. Observe the drawing above with relation to the definitions and abbreviations listed below.

- “**P.C.**” is the “point of curvature,” where the tangent (or straight) segment of the highway begins to curve.
- “**P.T**” is the “point of tangency,” where the curved segment of the highway ends and a new tangent segment begins.
- “**P.I**.” is the “point of intersection,” where the extension lines (dashed) of the tangent segments meet or intersect.

The location of these three points *(PC, PT and PI)* is shown by this symbol: ◯

P.C. and P.T. are on the centerline, P.I. is to the left or right of the centerline, depending on the direction of the highway curve (left or right.) Station numbers associated with these points are on the plan.

3-32. Use the drawing from topic 3-31 *(previous page)* **to answer the following questions.**

a. The abbreviation “P.C.” represents. _____

b. The abbreviation “P.T.” represents. _____

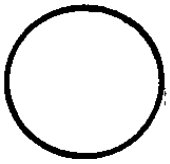
c. The abbreviation “P.I.” represents. _____

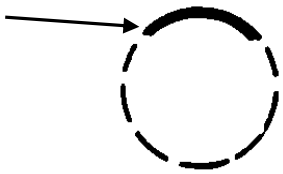
d. The curve begins at station number _____

e. The curve ends at station number _____

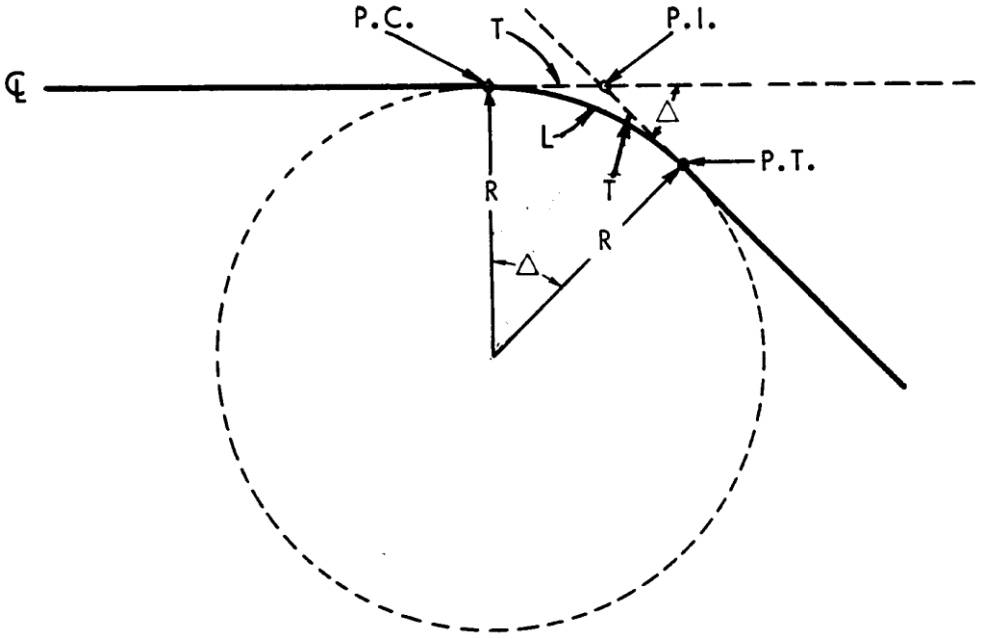
3-33. There are two major types of curves: circular and spiral. Only outdated plans show spiral curves, since the department has discontinued the practice.

Allowed to continue, a **circular curve** results in a circle.

This is a circle 

The solid part represents a circular curve 

Here is a curved segment, complete with dashed lines representing the entire circle *(for clarity, the station data is omitted.)*



3-34. Curve Data using the diagram from the previous page.

- Between the centerline symbol and the P.C. is the tangent segment of proposed road.
- A curved segment is between the P.C. and the P.T. (remember, the curve segment is part of a circle)
- The P.T. ends the curve and begins the next tangent segment of the proposed road.
- Extended, the tangent segments intersect at the P.I., as evidenced with the dashed line labeled "T."
- **T** is the tangent distance from the P.C. to the P.I. or the P.I. to the P.T. (both distances are equal)
- Even though the P.I. is not on the centerline, it has a station number. Finding this station number requires adding the tangent distance (T) to the station number of the P.C.
  This is <u>true only with the point of curvature</u> (P.C.) ... *not with the point of tangency*.

Here are some important notes:

- Curves cause a change in bearing.
- The tangent segment before the curve has a bearing.
- Likewise, the tangent segment after the curve has a new bearing.
- New bearing information occurs where the tangent lines (T) cross at P.I.
- **Delta (Δ)** is the mathematical symbol for change, it indicates the amount of **bearing change** to the right or left between the two tangent segments of the highway.
- **"R" is the radius**, the distance from the center of the circle to PC or the distance from the center of the circle to PT, as in the diagram (pg. 3-27)
- **"L" is the length of the curve** from the P.C. to the P.T.

3-35. Review the diagram from page 3-27; note the radii from the P.C. and the P.T. meet at the center of the circle. The angle between the two is equal to **Δ (Delta.)**

Given the curve data below, use the information from topics 3-31 – 3-34 to solve for the unknowns.

P.C. = station 23 + 42
Δ = 6° 34′ 54" Rt.
T = 2108 feet
Bearing (before P.C.) = N 53° 26′ 10" E

Adding bearing changes to P.C.

For example: Given Δ = 4° 36′ 23" Rt.
and the Bearing (before P.C.) = N 21° 32′ 45" E

What is the centerline bearing of the tangent segment after P.T?

add 4° 36′ 23"
+ 21° 32′ 45"
N 26° 09′ 08" E *(answer)*

a. What is the station number for P.I.? _____

b. What is the centerline bearing of the tangent segment **after** P.T.? _____
(hint: add Δ to the bearing… remember, there are only 60 seconds in a minute, and 60 minutes in an hour. Refer back to page 3-17, then, study the example above)

3-36. Calculating the station numbers for the P.I. and the P.T.

- To calculate the station number for the P.I., add the tangent length (T) to the station number of the P.C.
- To calculate the station number for the P.T., add the length of curvature (L) to the station number of the P.C.

Given the data below, solve for the unknowns.

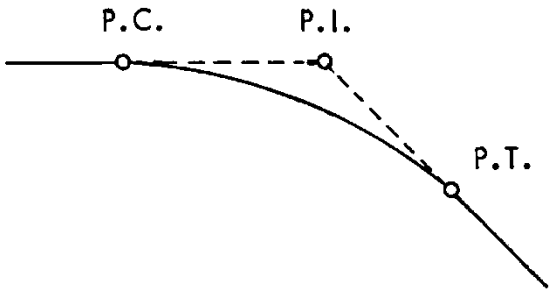
P.C. = Station 53 + 00
T = 505′
L = 693′

a. What is the station number for the P.I.? _____

b. What is the station number for the P.T.? _____

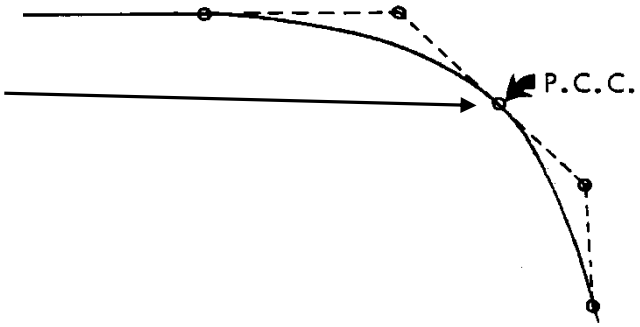
3-37. Compound Curves

Here is a simplified diagram of a curve:



When **two curves** join (one following the other,) a **point of compound curvature** (P.C.C.) or **point of reverse curvature** (P.R.C.) occurs.

Imagine a curve turning right and halfway through the radius changes. This is the "point of compound curvature" (P.C.C.)

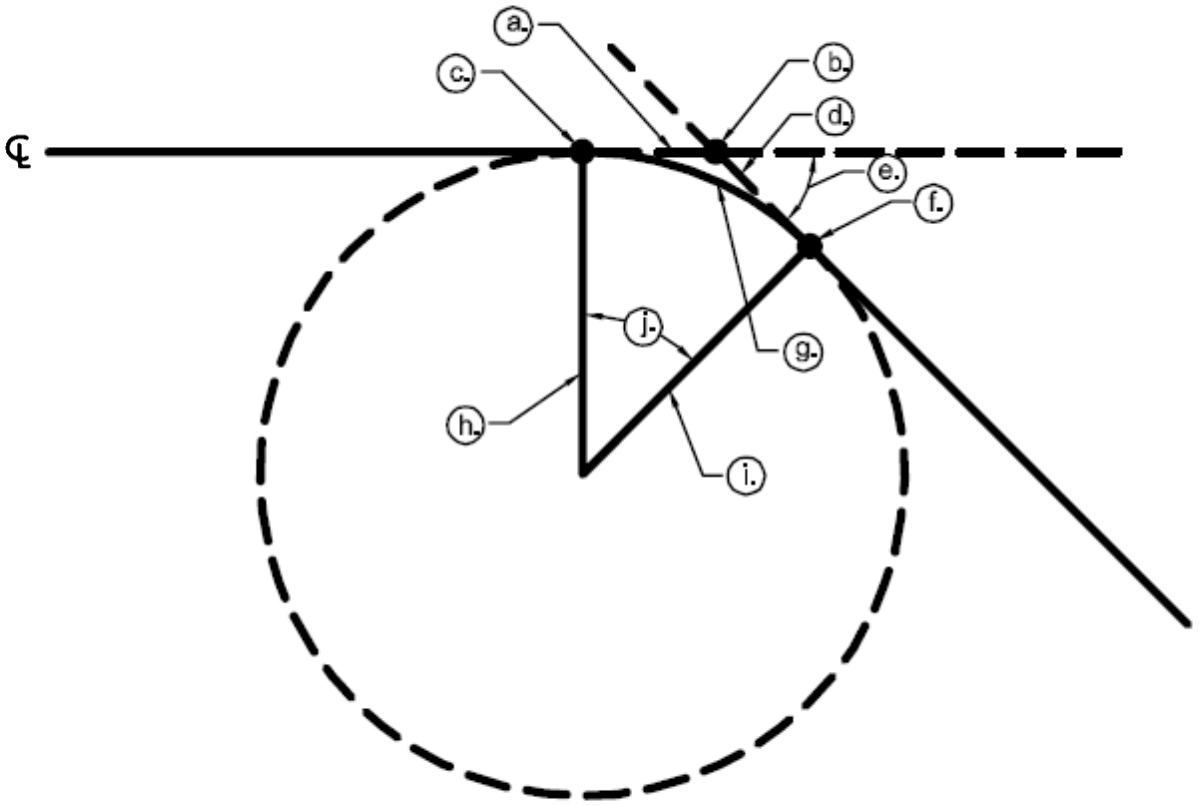


Uses for Compound Curves

Employing the use of compound curves enables a change in the end-point, or a change in the location of the point of tangency.

3-38. Matching. In the blank 2nd column, write the matching definition next to the symbol or abbreviation using the possible answers from the 3rd column.

	Symbols &. Abbreviations	Definitions	Possible Answers
a.	Δ		point of tangency
b.	P.I.		length of curve
c.	L		point of curvature
d.	T		radius
e.	P.T.		change in bearing
f.	R		point of intersection
g.	P.C.		tangent distance to P.I

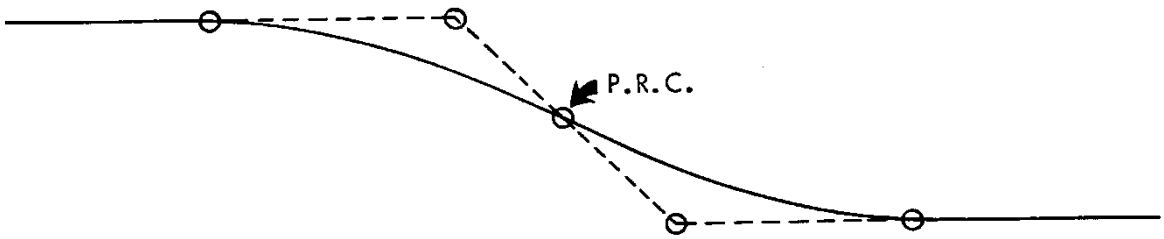


3-39. Review the diagram above, it depicts a RIGHT hand curve. Notice the circles containing letters. Each is pointing to a specific feature.
Record the appropriate symbols and/or abbreviations for the lines, points, angles, etc. next to the corresponding letters found in the 1st column.

a	
b	
c	
d	
e	
f	
g	
h	
i	
j	

Use the diagram from page 3-26 to confirm your answers.

3-40. When a curve (spiral or circular) joins another curve (spiral or circular,) and these curves are turning in opposite directions; it is a reverse curve. Essentially, the direction of curvature changes. This is the **point of reverse curvature** (P.R.C.). Reverse curves are avoided whenever possible.



Fill in the blanks with the correct definition for the following abbreviations.

a. P.C.C.? _____

b. P.R.C.? _____

3-41. Below is curve data information arranged similar to curve data written on R/W sheets. Use this information to answer the following questions.

Curve Data (Surv. Centerline)

P.I. = STA. 213 + 47.30

Δ = 7°35′ RT.

D = 2°00′

T = 457.36′

L = 702.78′

R = 6830.69′

a. What is the station number for the point of intersection? _____

b. Calculate the station number for the point of curvature_____

c. What is the radius of the curve? _____

d. What is the bearing change between the tangent segments? _____

e. Calculate the distance from the P.C. to P.I. _____

f. Record the distance from P.I. to P.T. _____

g. Record the length of curvature associated with curve? _____

CHAPTER THREE - REVIEW QUESTIONS

3-42. Given the parcel symbol letter/numeral combination, fill in the blank spaces with the appropriate answers.

	Letters associated with a given parcel symbol	Location (R/W Sheet)	R/W Parcel number	Type Of Parcel	Purpose or distinction	Has this parcel previously encountered changes? (Y/N)
a.	4-3-D-1					
b.	4-2-R-1					
c.	8-5-C-2					
d.	6-4-A-2					
e.	4-4					
f.	11-4-1					

3-43. Complete the table by recording the appropriate abbreviation or symbol in the blank provided

		abbreviation letters or symbol
a.	point of tangency	
b.	point of curvature	
c.	point of compound curvature	
d.	point of intersection	
e.	length of curvature	
f.	point of reverse curvature	
g.	radius	
h.	tangent length	
i.	bearing change	

CHAPTER THREE - REVIEW QUESTIONS *(continued)*

3-44. Fill in the blanks with the correct answer(s.)

a. Refer to sheet 96 (R/W sheet 1,) locate R/W Parcel 1-4. The department plans to purchase this parcel from _____.

b. What is the size of R/W parcel 1-4? _____ acres

c. Record the length associated with each side of R/W parcel 1-4.

North _____
South _____
East _____
West _____

d. How are the original real property corners of R/W parcel 1-4 identified?

_____

e. Record the station number associated with the north property line of R/W Parcel 1-4 _____

f. Record the station number associated with the southern property line of R/W Parcel 1-4 _____

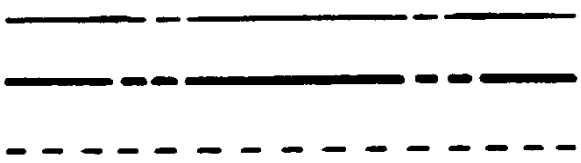
g. Adding "**ET UX.**" to a property owner name, indicates _____

3-45. Write the description of each line in the blank.

a. _____

b. _____

c. _____



CHAPTER THREE - REVIEW QUESTIONS *(continued)*

3-46. Refer to the Highway Plan Book, find Sheet 98, R/W Sheet 3.
Review the CURVE DATA written on the property line between the real property owned by Suzanne Aydell Howze, ET Al and Suzanne Krizansky Aydell, ET AL.

Answer the following questions, write the correct answer in the blank.

a. Record the Station number at P.T_____

b. Record the Station number at P.C. _____

c. Record the Station number at P.I. _____

d. Record the Bearing change between tangent segments _____

e. What is the Radius of the curve? _____

f. What is the Degree of curvature? _____

g. Calculate the distance between P.C. and P.I. _____

h. Calculate the distance between P.I. and P.T. _____

i. What is the Length of curvature?_____

j. Locate the centerline of LA 447 on Sheet 98 (R/W 3.) What is the centerline bearing of the tangent segment **after** P.T.? _____

k. What is the centerline bearing of the tangent segment **before** P.C.?_____

l. Record the total width of required R/W at P.C. (STA.145 + 78.10) _____

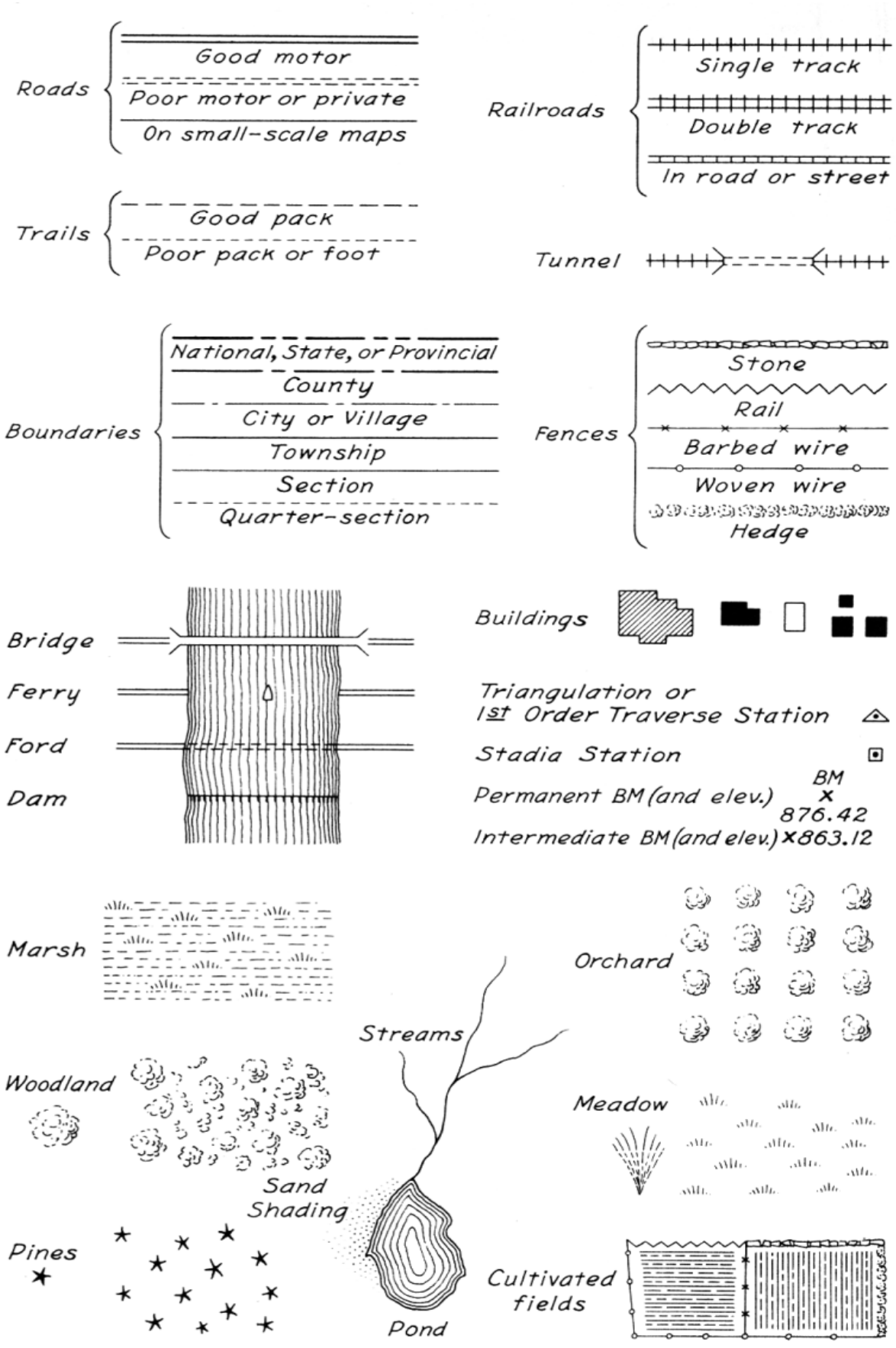
m. The tables in the lower and upper left hand corners of R/W sheet 3 reference _____ R/W parcels (how many?)

n. Record the bearing associated with the EASTERN property line of the real property owned by the First National Bank of Denham Springs._____

TRAINING NOTES

TRAINING NOTES

Topography Symbols



CHAPTER 4
PLAN AND PROFILE SHEETS

INTRODUCTION

Plan and Profile sheets show the construction project from two viewpoints. The top half of a Plan and Profile sheet shows the construction project in PLAN VIEW (from above,) while the bottom half shows the construction project in PROFILE VIEW (from the side).

Chapter 2 introduced the different views associated with objects; i.e. top, elevations (sides,) cross-section (inside). Plan and Profile sheets display the top (plan view) and cross-section (profile view).

Plan and Profile Sheets identify and appropriately label existing and proposed features of the project; houses, culverts, power poles, fences, old & new bridges, etc.

The index on Sheet 1 of the State Project H. 000238 (Drain Canal Bridges on U.S. 90) shows the absence of Plan and Profile sheets. Therefore this chapter will reference the Plan and Profile sheets from the State Project, I-12 – DUMPLIN CREEK.

Open the Highway Plan Book, turn to the Title Sheet for the State Project I-12 – DUMPLIN CREEK, and refer to the Index to Sheets. Note the Plan and Profile sheets for this project are 4-39; several of these sheets are in the Highway Plan Book. Review these sheets before progressing.

Throughout the chapter, consecutive **TOPIC** numbers indicate various facets of information pertaining to the Plan and Profile sheets. Occasionally, topic numbers will reference one another.

As in previous chapters, review questions relating to the subject information appear periodically. Complete each question, as they will become useful study guide material.

PLAN AND PROFILE VIEWS

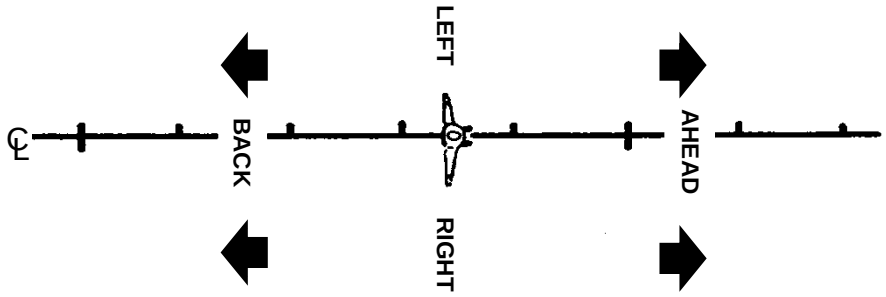
Turn to Sheet 4 in the Highway Plan Book. This is the first Plan and Profile sheet associated with State Project I-12 – DUMPLIN CREEK.

4-1. The **top half** of Sheet 4 is a **PLAN VIEW** presenting the construction project from the top (as if looking down).

Each "PLAN VIEW" on a Plan and Profile sheet displays the centerline of the road. It starts at the left of the sheet and continues to the right, moving on to the next sheet.

It is important to note that **everything drawn above the centerline is LEFT of the centerline, while anything drawn below is RIGHT of the centerline.**

The diagram below shows the PLAN VIEW; it is a "top" view. Observe the figure standing on the centerline facing ahead with outstretched arms pointing to the left and right.



4-2. The **bottom half** of Sheet 4 *(I-12, Dumplin Creek)* is a **PROFILE VIEW** representing the construction project from the side. It reveals a **LONGITUDINAL CROSS-SECTION VIEW** of the roadway's length as if looking at the right side of the construction project.

Below is a representation showing the two lines associated with the PROFILE VIEW (longitudinal cross-section).

4-2. *(continued)*

Fill in the blanks with the correct answer.

a. List the view represented in the top half of a Plan and Profile sheet._____

b. List the view represented in the bottom half of a Plan and Profile sheet._____

c. What do Plan and Profile Sheets identify?_____.

d. The _____ view (*Plan or Profile*) presents the side view of the roadways' length.

e. A profile view shows a _____ _____ of the roadway's length.

f. What sheet lists the pages of the Plan and Profile sheets?_____

g. What feature divides the PLAN view into Left and Right orientation?_____

h. Plan and Profile sheets "flow" in a constant direction, list the direction. (*north to south, south to north, left to right, right to left*)._____

4-3. Refer to the Title sheet for I – 12, Dumplin Creek in the Plan Book. Locate the scale information pertaining to the Plan and Profile Sheets; it is located in the lower left corner next to the Layout Map scale.

This is how the information appears.

DATUM USED: N.G.S.
MAG. VAR.: N/A
BEARINGS ARE: GRID
TRANSIT BOOKS: 159 – 387
LEVEL BOOKS: 159 – 290, 160 – 293, 160 – 923, 160 – 292, & 160 – 329

SCALES

PLAN: 1″ = 20′

*__PROFILE:__ **HOR. 1″ = 20′**
VERT. 1″ = 4′

*** Notice the scale indicated for the PLAN section (top half) of the Plan and Profile sheet is different from the PROFILE section (bottom half).**

- Only **one scale** (**1″= 20′**) is required to show the dimensions of a **plan view** *(top view)*

- **Two scales** are necessary to adequately represent the dimensions associated with a **profile view** (side); **horizontal (1″= 20′)** and **vertical (1″= 4′)**

4-4. Sometimes the plan reader may require Plan and Profile information from a Plan Set where the sheets have been reduced to one-half (1/2) the original size. Remember from Chapter 2, that in order to **measure** items on a ½-size sheet it requires doubling the scale.

***** So be careful **measuring** items on a half size sheet using the scale written on the sheet, it will result in measurements double that intended by the Engineer!

Simply put, reducing the size of the sheet by ½ requires the plan reader to double the scale when **measuring**.

For instance, if the scale written on a ½ size sheet reads 1″=10′, then the Engineering Scale used to **measure** items must be doubled to 1″=20′.

> **NOTE:** The sheets contained in the Highway Plan Book have NOT been proportionally reduced in size, and are therefore considered *Not-to-Scale* (**NTS**).

This course does *not* ask the student to measure; it only asks the student to **READ** the plans. Keeping that in mind, all dimensions written on the plan sheets will remain as they are described.

Consider the information from Topic 3, page 4-3. Fill in the blanks with the correct answers.

a. What scale is associated with the TOP half of the Plan and Profile sheets?_____

b. What is the HORIZONTAL scale associated with the PROFILE view on the Plan and Profile sheets?_____

c. What is the VERTICAL scale is associated with the PROFILE view on the Plan and Profile sheets?_____

d. Reducing the size of a Plan Sheet by one-half requires the plan reader to _____ the scale when **measuring** items.

4-5. **CUT** and **FILL** are two terms associated with the Profile view.

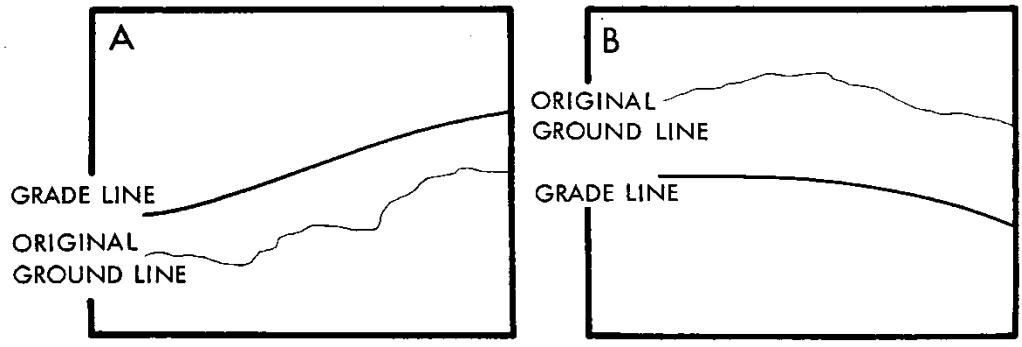
Illustrated above are two lines, one depicts the original ground line, the other, the proposed grade.

At times, the original ground line appears higher than the proposed grade line. When this occurs, earth is removed or **CUT** away during the grading process.

Likewise, when the original ground line appears lower than the proposed grade line, earth is added or **FILLED** in during grading.

- Adding earth = **FILL AREA**
- Removing earth = **CUT AREA**

Consider the grade sketches below, fill in the blanks with the correct answer.



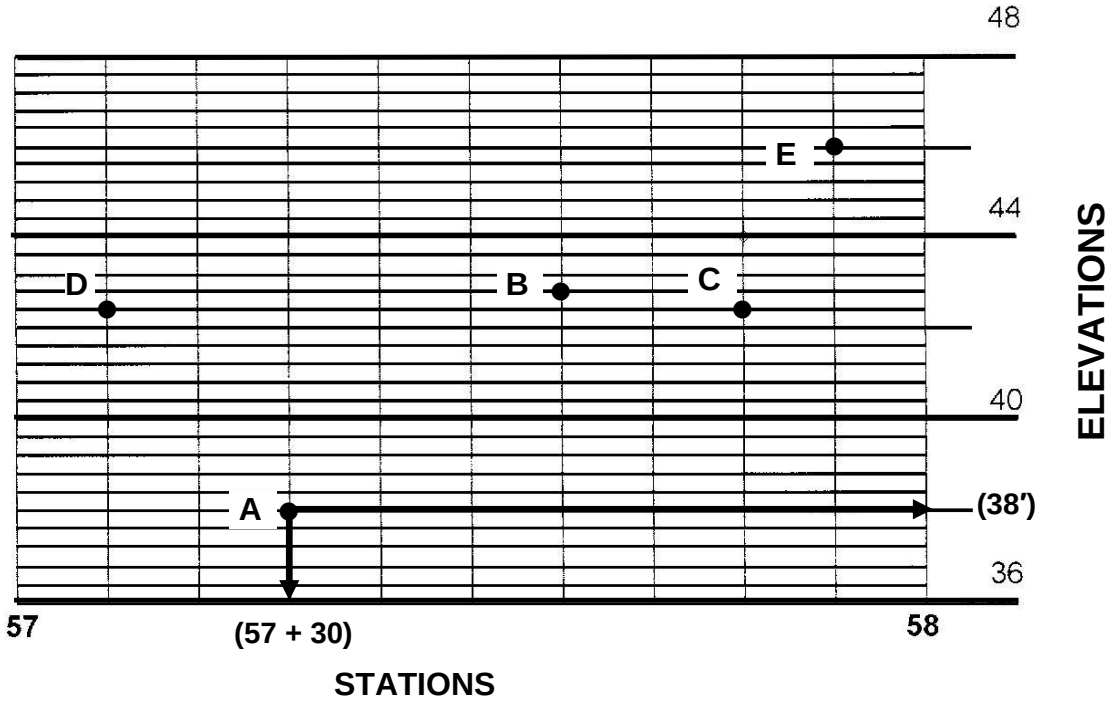
a. True or False. Consider sketch “A”. The area between the original ground and the proposed grade is a cut. _____

b. True or False. Consider sketch “B”. The area between the original ground and the proposed grade is a fill. _____

4-6. The diagram at the bottom of the page is a representation of a PROFILE view. The project in the Highway Plan Book is similar to the illustration, and uses the same scale. Here is some additional information regarding Profile Views.

- The numbers in the RIGHT margin indicate elevations above sea level.
- Each horizontal line represents 0.4′ in elevation.
- Each vertical line represents 10 feet in distance.
- The numbers on the bottom are station numbers.
- When the horizontal scale is greater than 1″ = 20′, full station numbers are shown at five-station increments. For other stations, only the last digit(s) appears.
- At one-inch intervals, heavy horizontal lines represent elevations at multiples of the elevation scale (*1″ = 4′*) i.e. 36′, 40′, 44′, etc.

- At point "**A**," the station number is **57 + 30**
  (each vertical line represents 10 feet)
- The elevation is **38′**
  (5 lines above 36′, each represents 0.4′, and 5 X 0.4′ = 2.0 feet)



4-6. *(continued)*

Use the illustration from Topic 4-6 to answer the following questions. Fill in the blanks with the correct answer.

a. Point B is at station _____, and has an elevation of _____.

b. Point C is at station _____, and has an elevation of _____.

c. Point D is at station _____, and has an elevation of _____.

d. Point E is at station _____, and has an elevation of _____.

Continue using the illustration from Topic 4-6 to answer these questions.

e. Point E is _____ feet ahead of point D.

f. Point E is _____ feet above point C.

g. Point C is _____ feet above point A.

h. Point A is _____ feet behind of point E.

i. Point D is _____ feet below point B.

4-7. Below are the Profile View scales as described on the Title page (refer to Topic 4-3).

Horizontally (left to right) 1″ = 20′
Vertically (up and down) 1″ = 4′

- If the illustration from Topic 4-6, was on a set of full size plans, and the horizontal distance between Stations 57 + 00 and 57 + 30 measures 1.5 inches (1- ½”). Then, using the scale 1″= 20′, thirty feet separate the two stations.

- Likewise, if the vertical distance between elevations 44 and 48 measured 1 inch. Using the scale 1″= 4′, four (4) feet separate the two elevations.

Remember, measuring on Plan Sheets reduced by ½ changes the scale. For instance, 1″= 20′ becomes 1″= 40′ and 1″= 4′ becomes 1″= 8′.

While our concerns deal with “reading” the plans, it may become necessary to measure an object on a reduced size sheet. Be sure to check if the sheet has been proportionally reduced so you can use the appropriate engineering scale. For example, if a full size sheet calls for the scale 1″=10′, reducing the sheet size by ½, requires changing the scale proportionally to 1″=20′

4-7. *(continued)*

Consider using the 1″= 20′ scale to measure horizontal distances on a full size Plan and Profile sheet. Calculate the distance and record the answer in the blank provided.

For example: 5-1/2 horizontal inches = 110 feet

a. 2-1/2 horizontal inches = _____ feet

b. 6 horizontal inches = _____ feet

Consider using the 1″= 4′ scale to measure vertical distances on a full size Plan and Profile sheet. Calculate the distance and record the answer in the blank provided.

For example: 10 vertical inches = 40 feet

c. 2 vertical inches = _____ feet

d. 3/4 vertical inches = _____ feet

4-8. Refer to Plan and Profile Sheet 13 *(I-12, Dumplin Creek)* in the Highway Plan Book. Observe how the PLAN portion is “in line” with the PROFILE portion. Examine the station numbers at the top and bottom of the sheet. Notice they too are “in-line”. Understand that the PLAN and PROFILE views share information as a “unit.”

4-9. Again, refer to Plan and Profile Sheet 13 *(I-12, Dumplin Creek)* in the Highway Plan Book. Notice the continuous, dark, heavy line on the PROFILE view (bottom). This is the **proposed grade line**, the expected result of the road project.

A lighter, thinner line indicates the original ground. This is the **existing grade line**. Often this line is very irregular, as it is depicting the original ground at the new road location prior to grading (recall the illustration in Topic 4- 2).

Sometimes a proposed road project will be constructed over the same location as the existing roadway; then the original ground line would appear smooth, as is the case with the I-12, Dumplin Creek project.

4-9. *(continued)*

Using the Plan and Profile Sheet 13 *(I-12, Dumplin Creek)* **in the Highway Plan Book, fill in the blanks below with the correct answer.**

a. The **heavy line** drawn in the profile view represents_____

b. The **light line** drawn in the profile view represents_____

c. Record the elevation of the **existing** grade at station 157 + 40._____

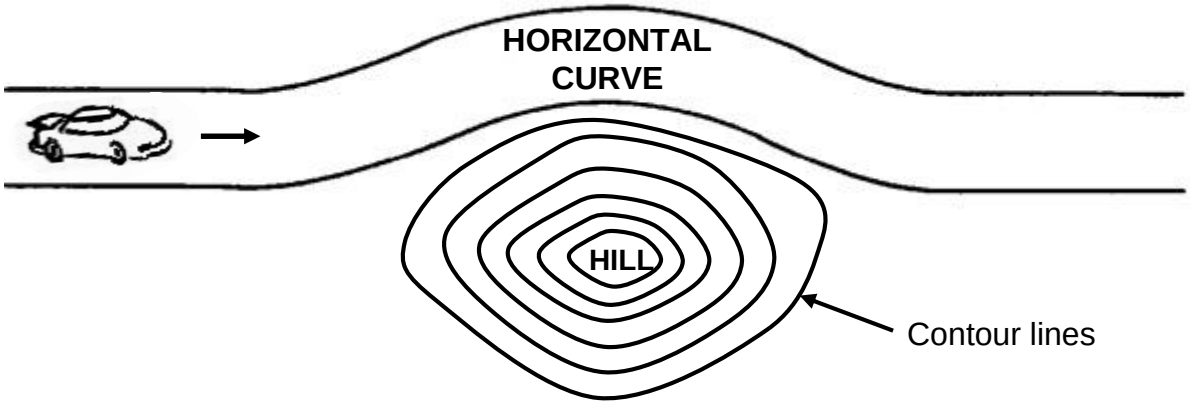
d. Record the elevation of the **proposed** grade at station 157 + 40._____

e. Is the area at STA. 157+ 40 a cut area or a fill area? _____

f. Plan and Profile sheet 13 shows a proposed road project built over an existing roadway. Therefore the centerline in the plan view represents the_____ _____ *(hint, 2 words)* and the _____ _____ *(hint, 2 words)* in the profile view.

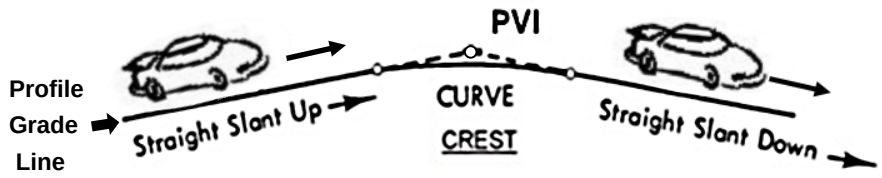
CURVES

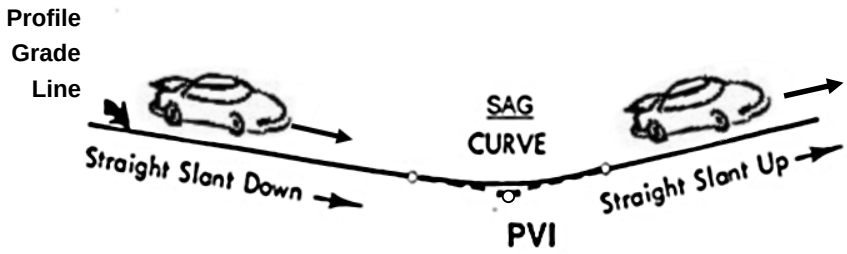
4-10. Many times in a PLAN view the proposed road shows curves leading **around** obstacles, instead of going over or through them. These are **HORIZONTAL CURVES**. Below is a **Plan View** illustration of a highway curve going **around** a hill.



4-11. **VERTICAL CURVES** occur in two instances: when the proposed highway **goes over a hilltop** (crest) or when it travels **down into a valley** (sag).

Below are two **Profile View** illustrations: a vertical curve going over a hill (crest), and a vertical curve slanting into a valley (sag).





a. Profile Views identify _____ curves.

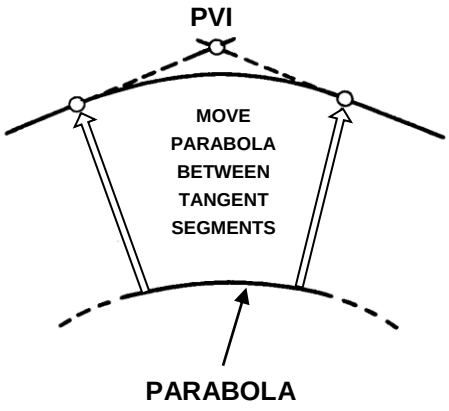
4-12. It is possible for a highway to have a horizontal curve at the same place it has a vertical curve. However, there is **NO** relationship between a horizontal curve and a vertical curve.

- **Plan Views** show horizontal curves, not vertical curves.
- **Profile Views** show vertical curves, not horizontal curves.

Fortunately, both the Plan and Profile views are on the same sheet!

4-13. Chapter 3 discussed **Horizontal curves**, which are generally **circular curves**. This is not true for vertical curves, as **Vertical curves are parabolic**.

Examine the drawing to the right, notice the sketch of a **parabola** at the bottom.



To make a vertical curve, a “section” of the parabola fits in between the tangent segments of the highway.

This parabola is for a hill or crest. Turned upside down, it reveals a vertical curve for a **valley** or **sag**.

Fill in the blanks with the correct answer.

a. What view depicts Horizontal curves?_____

b. What view depicts Vertical curves?_____

c. Horizontal curves are generally_____ curves.

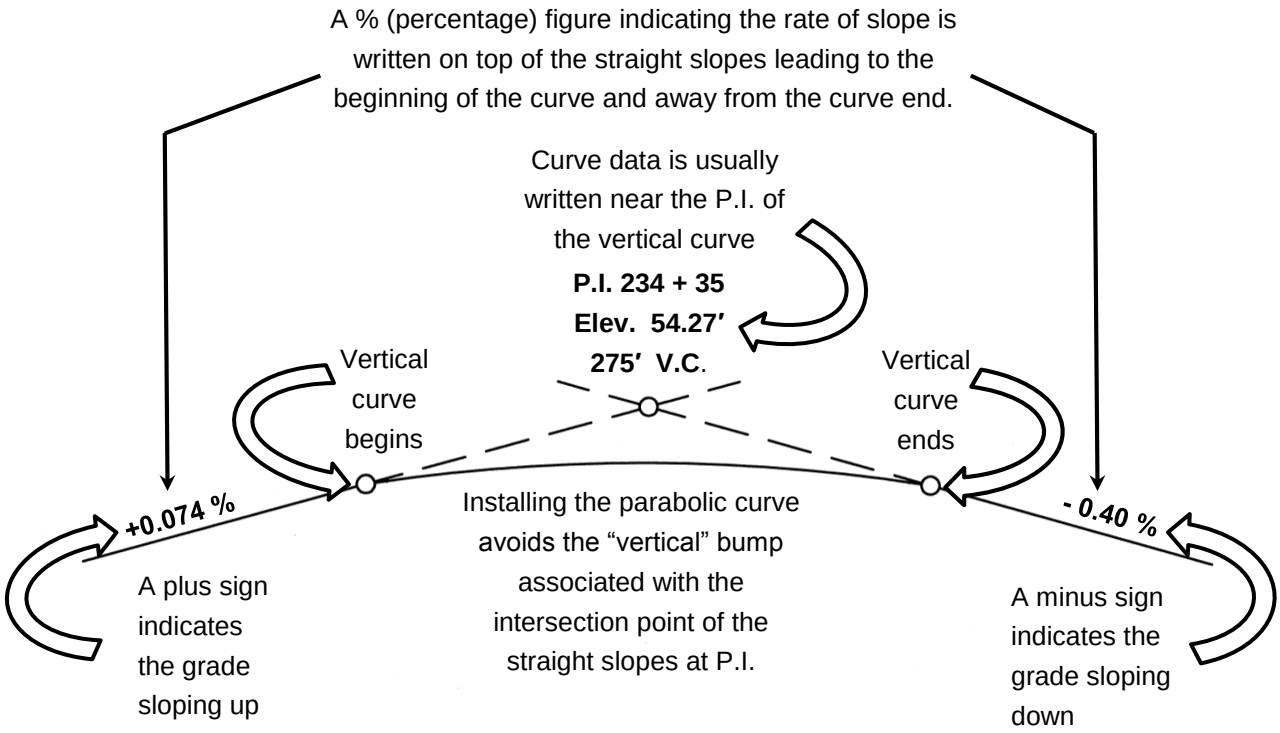
d. Vertical curves are _____ curves.

4-14. Profile views show the elevation of the existing ground and the proposed grade of the highway.

- "**GRADE**" is the slope of the land. A perfectly level road has a "grade" of zero.
- When the grade slopes up, it is a rising or increasing grade.
- A grade sloping down is a falling or decreasing grade.

Grade is expressed as a percentage of slope per 100 feet. A road gaining one foot in elevation per 100 linear feet has a "+ 1.00% slope" or rise in grade. Likewise, a road gaining one-half foot in elevation per 100 linear feet has a "+ 0.50% slope" or rise in grade.

4-15. Below is an illustration of a Vertical Curve with straight slopes on either side. Although different from horizontal curves, notice the similarities, in particular the terminology, descriptions, and drawing components



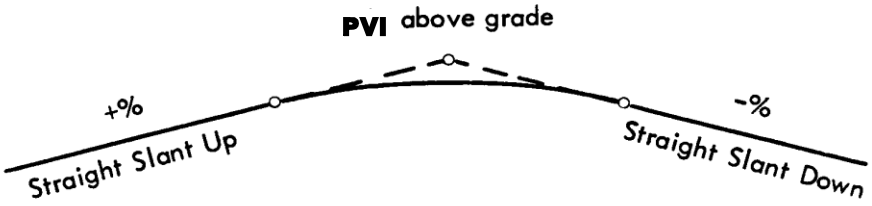
4-15. *(continued)*

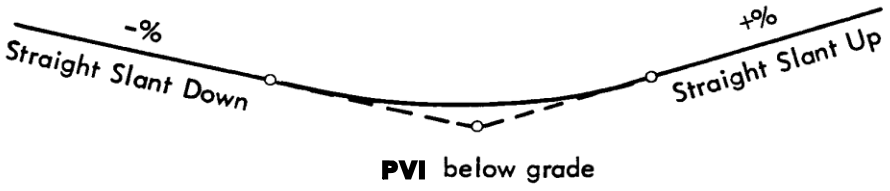
Given the following information, calculate the percentage grade (slope) for the following elevation changes per 100 feet. *(Include positive or negative slope indicators)*

	ELEVATION CHANGE	GRADE (%)
Example	*2 foot rise*	*+ 2.00% slope*
a.	4 foot fall	
b.	2.25 foot rise	
c.	.75 foot fall	
d.	34 foot rise	
e.	4.71 foot rise	

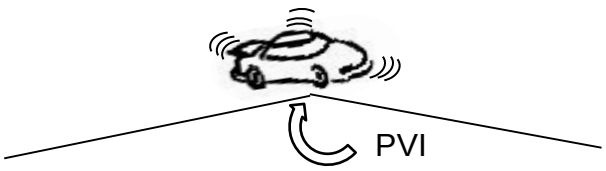
4-16. Just as Chapter 3 described the location of the horizontal P.I. being on one side or the other of the centerline, the same thing is true for the Vertical P.I. with respect to the proposed grade line.

Vertical P.I. (P.V.I.) is either above or below the grade. Drawn below are two curves, each indicating above or below grade placement of PVI.





IF PVI were on the grade line, a "vertical corner" would appear. Cars would not appreciate the "jolt" and subsequent bounce.



4-17. At times, when reviewing a Plan and Profile Sheet, it is difficult to distinguish an existing grade line from a proposed grade line. Review the illustration from Topic 4- 16; recall that the **proposed grade line has small circles** on it indicating the beginning and end of vertical curves.

Fill in the blanks next to the "letter" abbreviations with the correct term.

a. P.C. = _____

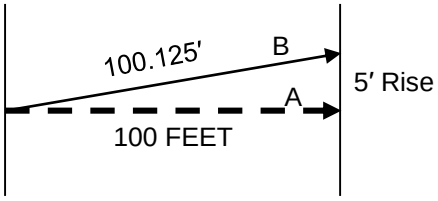
b. P.T. = _____

c. P.V.I. = _____

4-18. Review the grade and slope information from Topic 4- 15.
The rate of slope is per 100 linear feet, measured straight across, ***not along*** the grade. Grades slope up or down. Measuring the distance along the grade produces a longer distance.

Look at the example to the right.

- Line A (dashed) is a horizontal line 100 feet long
- Line B (solid) represents a sloping grade.
  - Line B has a rise of 5 feet, which is a "+ 5.00%" rate of slope. The plus (+) sign indicates a positive rise in elevation.
  - Use of the Pythagorean Theorem (equation) proves the added distance to line "B"
  - It is possible to calculate the elevation of any point along the proposed grade, relative to known elevation (on the slope), given the "rate of slope."



$$a^2 + b^2 = c^2$$

4-19. Open the Highway Plan Book and locate Plan and Profile Sheet 13 *(I-12, Dumplin Creek)*.

Do the following to obtain an ***approximate*** elevation of a point on the proposed grade line.

- Choose a point along the Proposed Grade line (heavy line). Notice that it intersects a horizontal grid line or is between 2 horizontal grid lines. Follow the horizontal grid line to the right, then read (*interpret/approximate*) the elevation numbers.

Approximating "point" elevations is just that… an approximation. Consequently, **existing** grade elevations appear at every station along the bottom of Plan and Profile sheet 13.

Utilize Plan and Profile Sheet 13 *(I-12, Dumplin Creek)* to record the **existing** grade elevations at the following stations.

STA. 152 + 00 _____
STA. 154 + 00 _____
STA. 156 + 00 _____
STA. 158 + 00 _____

4-20. Reducing the sheet size creates difficulty reading the Plan and Profile sheet; however, with each examination of the sheet your eyes become adjusted to the small spacing. Use a magnifying glass if reading the Profile View proves too difficult.

Observe the profile view on Plan and Profile Sheet 13 *(I-12, Dumplin Creek)*. It reveals two vertical curves. Find the vertical curve with the P.I. (point of intersection) at Station 154 + 25.

- Small circles delineate the Point of Curvature, the Point of Intersection, and the Point of Tangency.
- Percentages written on the grade line indicate slopes for the proposed grade before and after the vertical curve (see Topics 4-15 &16).

4-20. *(continued)*

- The station elevation (STA. 154 + 25) is recorded at the P.I. location.
- 135′ V.C. indicates a 135-foot vertical curve. In this instance, it is the horizontal distance (*see Topic 4-18*) between the Point of curvature and the point of tangency (the beginning and end of the vertical curve.)
- This vertical curve is a crest. Listing the P.I. information **above** a vertical curve is indicative of a **crest**.
- Conversely, P.I. information written **beneath** the grade line indicates a "**sag**" (see Station 157 + 10).

Refer to the <u>SECOND</u> vertical curve located on Plan and Profile Sheet 13 *(I-12, Dumplin Creek)*. Fill in the blanks with the correct answer.

a. Is this curve a sag or crest? _____

b. Record the elevation of the vertical P.I. _____

c. Record the length of the vertical curve _____

d. Record the station number of the P.I. _____

e. Record (*estimate*) the station number of the P.C. _____

f. Record (*estimate*) the station number of the P.T ._____

g. Record the slope after the vertical curve _____

4-21. Look along the bottom of Plan and Profile Sheet 13 *(I-12, Dumplin Creek)*, above station 155, there is a notation referring to the earthwork required for this part of the project. Calculated values appear as notations indicating the amount of cut and fill between Stations 148 +00 and 165 + 23.8.

- 14,148 cubic yards of general excavation (cut)
- 183 cubic yards of embankment (fill).

Since there is significantly more excavation than embankment, this notation indicates a "cut" situation.

Turn to Plan and Profile Sheet 12 *(I-12, Dumplin Creek)* in the Highway Plan Book and locate station 148 + 00. Notice that an arrowhead depicts the **beginning** of the earthwork. Similarly, on Plan and Profile Sheet 15 *(I-12, Dumplin Creek)*, another arrowhead at station 165 + 23.8 indicates the **end** of the earthwork.

4-21. *(continued)*

If the earthwork notation numbers were reversed, the situation would result in a deficit. The **Excavated** (cut) material will not produce enough "fill" material. This requires the department to "**borrow**" earth from another location.

For example, if a notation indicates 1000 CU. YDS. of embankment (*fill*), and 200 CU. YDS. of excavation (*cut*), additional earth is needed. "**Borrowing**" earth from another location takes place. Below are the "*borrow*" calculations."

1000 cubic yards embankment
+200 additional cubic yards of fill required to account for **compaction** (20%)
1200 total cubic yards of "fill" material required

- Subtract 200 cubic yards - original excavated earth (cut) is "re-used" as fill. (*note: not all excavated material is suitable fill material*)

- 1000 additional cubic yards of "**borrowed**" earth are required from another source to complete this phase of the project.

Calculating Cut and Fill

Consider a Profile notation indicating 630 CU. YDS. of general excavation and 1250 CU. YDS. of embankment. Record the correct answers to the questions in the following blanks.

a. Does this notation indicate a "cut" or "fill" situation? _____
b. CU. YDS is the abbreviation for _____
c. How much fill is available? _____
d. What is the percentage allowed for compaction? _____
e. Describe the term "borrow." _____
f. Does this notation indicate a "borrow" situation? _____
g If the notation indicates the need for additional fill material, calculate the amount. Show your work in the blank space below.

4-22. Turn to Plan and Profile Sheet 13 *(I-12, Dumplin Creek)* in the Highway Plan Book. Observe the note "**TBM #4**" located along the top of the Profile view near Station 154.

Occasionally during construction, it becomes necessary to remove a permanent **benchmark** (a point of known elevation and location). When this occurs, it requires the installation of a TBM, a temporary intermediate benchmark (see the diagram below). "TBM" is the abbreviation for "**temporary benchmark**."

L.G.S. B2909	60d NAIL IN 20″ PINE	L.G.S. B2510
45′ RT. STA. 90 + 15	24′ RT. STA. 99 + 50	30′ RT. STA. 109 + 49
ELEV. 44.56′	ELEV. 47.84′	ELEV. 44.94′

The Louisiana Geodetic Survey (L.G.S.), a government agency, surveys and installs permanent benchmarks. The diagram shown above depicts two permanent Benchmarks, sometimes known as monuments, and a TBM. Below the diagram is the qualifying information for each benchmark, as recorded in survey journals.

Listed below are the explanations for the BM and TBM qualifying information, notes, and abbreviations.

B.M.	-	abbreviation for "benchmark"
TBM	-	abbreviation for "temporary benchmark"
L.G.S. B2909 or L.G.S. B2510	-	abbreviation for "Louisiana Geodetic Survey" and the benchmark registration numbers.
45′ RT. STA. 90 + 15	-	The B.M. is located 45′ to the right of Station 90 + 15
ELEV. 44.56′	-	The "elevation" of this B.M. is 44.56 feet
TBM 60d NAIL IN 20″ PINE	-	the TBM is a sixty penny (d) nail driven in a 20 inch diameter pine tree
24′ RT. STA. 99 + 50	-	TBM is located 24 feet right of Station 99+50
ELEV. 47.84′	-	The TBM elevation is 47.84 feet

4-23. Facts concerning Benchmarks (BM)

- A BM is an accurate measurement of elevation.
- Recorded at each BM is a registration number, the location, and the elevation
- The department keeps a file of permanent benchmarks.
- Both permanent and temporary benchmarks give a point of known elevation and location.
- The department uses a BM to obtain the elevation at the starting point of a project.
- At the end of a project, survey crews will check another permanent BM. This facilitates an elevation "double-check," looking for errors with regard to elevation calculations

Answer the following questions. Write the correct answer in the blank

a. The abbreviation B.M. indicates_____

b. The abbreviation T.B.M. indicates _____

c. Describe the abbreviation - *TBM 60d NAIL IN 30″ PINE*

_____

d Describe the notation - 29′ RT. STA. 88 + 49 _____

e. The abbreviation L.G.S. indicates _____

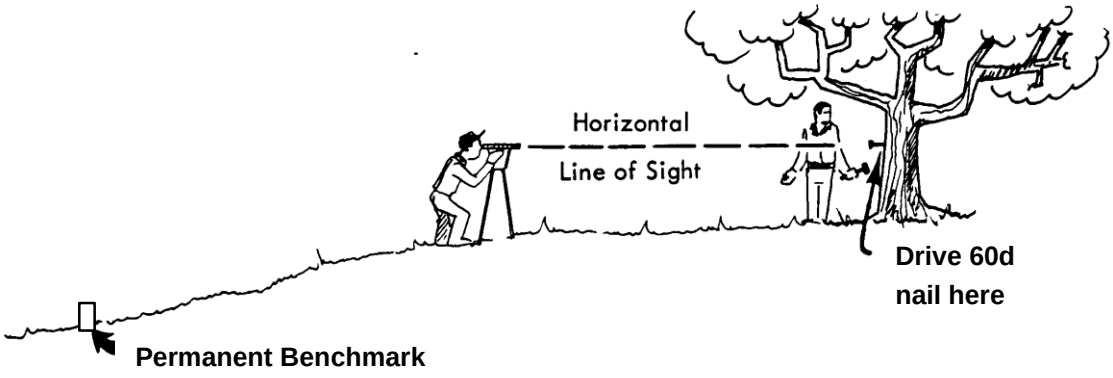
f. Describe ***L.G.S. B3456*** _____

g. *True or False*. The department maintains a record of permanent benchmarks. _____

h. Permanent and temporary benchmarks give a point of known _____ and _____.

4-24. Use the following steps to obtain the elevation of a temporary benchmark using a 60d nail and a tree.

A. Set up a level (telescope/instrument) to see the tree in a straight, horizontal line of sight as shown below.

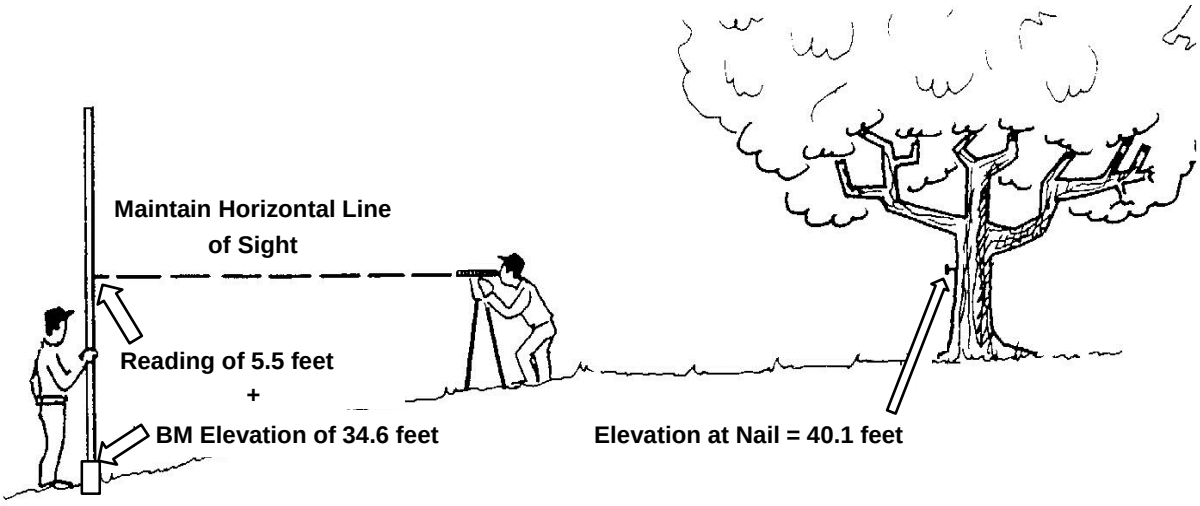


B. Drive (hammer) the 60d nail in the tree at the sight point (above)

C. Turn the level so it is looking toward the permanent BM, maintaining the same horizontal line of sight as shown in the illustration below.

D. Place a survey rod on top of the permanent BM, read the measurement (5.5 feet)

E. Add the measurement (5.5 feet) to the elevation of the permanent BM (34.6 feet.) The elevation at the TBM is 40.1 feet.



4-25. Refer back to Plan and Profile Sheet 13 *(I-12, Dumplin Creek)* found in the Highway Plan Book. Find the **TBM,** and its qualifying information (look along the top of the Profile view at approximately Station 154.) Record the following information about the TBM.

a. T.B.M. #: _____

b. Type of Marker: _____

c. Marker Location: _____

d. Marker Elevation: _____

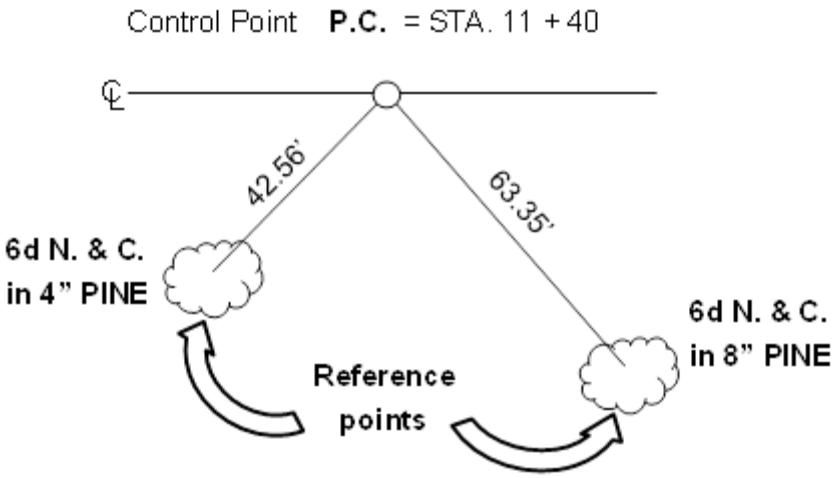
HORIZONTAL CURVES

4-26. Chapter 3 covered Horizontal curve basics. Recall that the P.C., P.I. and P.T. of a horizontal curve are ***control points*** used to locate the centerline. Stakes placed in the ground locate these points prior to construction.

On occasion, a control point stake becomes dislodged or removed. To avoid losing the location of these points, a survey crew establishes "**reference points**" prior to construction, taking care to place them at an approximate 70° angle to the centerline. Reference points are "***tied***" to control points by means of TBMs.

- Although only two reference points are necessary to re-establish the location of a lost control point, creating more is a frequent practice.

In the diagram below, P.C. is the control point and the two reference points are 6-



penny (d) nails (N) and bottle caps (C) in two pine trees.

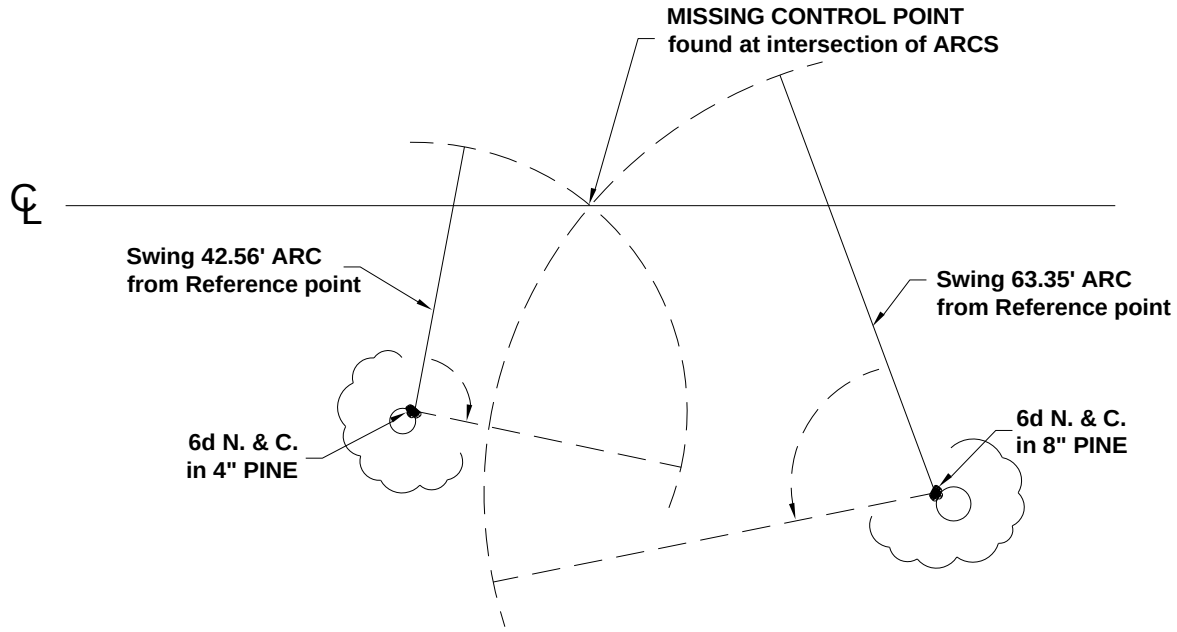
4-26. *(continued)*

Reference point diagrams indicate station points and the centerline. Reference Points appear either “left” of the centerline, or “right” of the centerline. A couple of good reference diagram examples are shown on Sheet 7, *I-12, Dumplin Creek.*

4-27. PROCESS FOR FINDING MISSING CONTROL POINT

A. Obtain a string, cloth tape, or similar object the same length of the recorded distance from the reference point to the control point.
B. Attach one end of a string, cloth tape, or similar object to the reference point.
C. Swing an arc from each reference point, using it as the center point (see the drawing below).
D. The intersection of the two arcs provides the location of the missing control point.

The diagram below illustrates the process of locating a missing control point.



4-27. *(continued)*

Fill in the blanks with the correct information with regard to the control point found between Stations 120+00 and 121+00 on Sheet 7 *(I-12, Dumplin Creek)*

a. The control point is at station _____

b. The 12″ oak tree is _____ feet from the control point.

c. The "**Y**" on the concrete culvert is _____ feet from the control point.

d. The control point is the _____ located on the _____.

e. How many reference points are required to relocate a control point?_____

4-28. Open the Highway Plan Book. Locate Plan and Profile Sheet 12 *(I-12, Dumplin Creek)* and find the horizontal curve (top half of the sheet).

Located near the property owner name "William I. Aydell ET UX," is data with regard to the control point and reference points for the highway curve.

Plan and Profile Sheet 12 *(I-12, Dumplin Creek)* shows discrepancies between the station number information recorded on the centerline and the station number information recorded on the reference point diagrams. For the purposes of this manual, fill in the following blanks **using the Reference Point diagram** information for the P.I. and P.T.

Part 1 - with regard to the Reference Point at P.I.

a. Record the Station number for the P.I. _____

b. What device depicts the location of the P.I.?_____

c. How many reference points are associated with the P.I.? _____

d. Record the distance to the furthest reference point. _____

e. Record the type reference point (with regard to question "d" above.)

_____

f. Record the distance from P.I. to the fire hydrant reference point. _____

g. What is reference point mark is associated with the fire hydrant?_____

4-28. *(continued)*

Part 2 - with regard to the Reference Point at P.T.

a. Record the Station number for the P.T. _____

b. What device depicts the location of the P.T.?_____

c. How many reference points are associated with the P.T.? _____

d. Record the distance to the furthest reference point from the P.T._____

e. Record the type reference point (with regard to question "d" above.)

_____

READING THE PLAN AND PROFILE SHEET

4-29. Recall from the introduction to this chapter.

> *"Plan and Profile sheets show the construction project from two viewpoints. The top half of a Plan and Profile sheet shows the construction project in PLAN VIEW (from above,) while the bottom half shows the construction project in PROFILE VIEW (from the side).*

Although the plan and profile are two different views of the project, together they give information to the reader at specific locations (i.e. usually station numbers).

Locate Plan and Profile Sheets 5 and 6 *(I-12, Dumplin Creek)* in the Highway Plan Book. While Sheet 4 is the first drawing in the Plan and Profile section, its use is primarily for reference purposes.

Sheet 5 is actually the beginning of the project.
Locate the start of the project (beginning). Fill in the following blanks with the correct answers.

a. Record the beginning station number of the proposed project?_____

b. Refer to the profile view on sheet 5; **is** a change in elevation proposed at the beginning station? _____

4-30. Refer to Plan and Profile Sheet 6 *(I-12, Dumplin Creek)*. As discussed previously, the heavy line in the profile view represents the proposed roadway grade, while the original ground line is a thin line.

Vertical letters at the beginning (left side) and end (right side) of each sheet are the grade-line elevation; it is labeled either **subgrade** or **finished grade**.

Use the Plan and Profile Sheets *(I-12, Dumplin Creek)* located Highway Plan Book to fill in the following blanks with the correct answers.

a. What is the roadway grade elevation at station 116 + 00? _____

b. Is this a subgrade or finished grade elevation? _____

Refer back to Plan and Profile Sheet 6

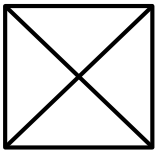
c. Will the department purchase any "additional right-of-ways"?_____

d. In the space provided, **draw an R/W line**.

e. Does the plan view show a **control of access** right-of-way line? _____

f. In the space provided, **draw a control of access R/W line**. (Hint: Look in the upper left corner of sheet 6, notice the term "*REQ'D **C** of **A***"

4-31. This symbol represents the location of an **R/W marker**. Turn to Plan and Profile Sheet 6 *(I-12, Dumplin Creek)*. Use a magnifying glass to look along the bottom edge of the Plan View, near the middle, locate two symbols like the one shown below. They are on the edges (corners) of the Right-of-Way.



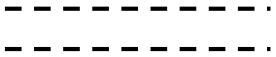
Use Plan and Profile Sheet 6 to fill in the following blanks with the correct answers.

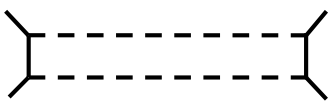
a. How many R/W markers does Plan and Profile Sheet 6 show? _____
(Hint: look near the property owned by Edna McGuire ET AL, and the north-west corner of the intersection of LA 447 and Pendarvis Lane.)

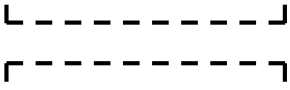
4-32. Dashed lines (sometimes referred to as dotted lines) used alone, or in combinations, depict many objects or boundaries.

For instance, dashed lines similar to the one shown below indicate "**limits of construction**."

Shown below are other uses for dashed (dotted) lines.

Existing Road 

Existing Bridge 

Existing Drainage Structure 

4-33. Notations on plan and profile sheets indicate if existing objects are **to remain or be removed**. Sometimes the notes simply describe objects. These notes are commonly found within the profile area; however, they are occasionally located in the plan area near the object.

- Refer to Plan and Profile Sheet 25A *(I-12, Dumplin Creek)* located in the Highway Plan Book. Notice several notes at the **top of the profile section**. Each refers to an existing or pending construction (*to be constructed*) drainage structure.

- Located at the top of the plan section, near Station 60 + 00, a note refers to an existing structure. Observe that this notation includes the station number indicating the beginning point of the structure. Similar notations also indicate station numbers of the structures.

Utilize Plan and Profile Sheet 25A *(I-12, Dumplin Creek)* **to fill in the following blanks with the correct answers.**

a. List 2 station numbers of the existing drainage structures slated for removal?_____

b. How many existing drainage structures will remain? _____

Notations Depicting Different Types of Drainage Structures scheduled for installation, removal or replacement

4-34. Observe Plan and Profile Sheet **25A** *(I-12, Dumplin Creek)*. There is a notation at the top of the Profile section at Station 62 + 10. It reads:

STATION 62 + 10
EXIST. 18″ X 68′ R.C.P. RT.
TO BE REMOVED
REQ'D. 24″ X 44′ S.D. RT.

4-34. *(continued)*

There are two parts to this notation. The first part describes the existing drainage structure and subsequent removal, while the second part indicates the installation of a new drainage structure.

Here are the definitions for the various drainage notation abbreviations.

EXIST.	=	an existing pipe
18″ X 68′	=	an 18″ diameter pipe 68 feet long
R.C.P.	=	a reinforced concrete pipe
RT.	=	located on the Right Side of the center line
TO BE REMOVED	=	to be removed
REQ'D.	=	required
24″ X 44′	=	a 24″ diameter pipe 44 feet long
S. D.	=	a side drain pipe
LT.	=	located on the Left Side of the centerline.

Simply put, at Station 62 + 10 there is an existing drainage pipe 18″ in diameter by 68′ long located on the right side of the highway centerline under a drive.

Reasons for the replacement vary. The department determined it is necessary to remove the existing pipe and replace it with a new drainage pipe 24″ in diameter by 44′ long.

Observe the corresponding symbols on the Plan View at STA. 62 + 10. They show the new pipe drawn over the existing pipe, indicating the new pipe will replace the old pipe at the same location.

4-35. Use Plan and Profile Sheet 25A *(I-12, Dumplin Creek)* to fill in the following blanks with the correct answers.

Record the data for the structure located at Station 64 + 60.

a. diameter:_____

b. length:_____

c. type of structure: _____

4-36. Locate Plan and Profile Sheet 13 *(I-12, Dumplin Creek)* in the Highway Plan Book. Fill in the blanks below with data regarding the **first vertical curve**.

a. Record the grade of the slope before the curve._____

b. Record the station number of the P.C. _____

c. Record the station number of the P.I. _____

d. What is the Elevation at the P.I.? _____

e. Record the Horizontal length of the Vertical Curve. _____

f. What is the Station number at the P.T.? _____

g. Record the grade of slope after the curve._____

h. Is this Vertical Curve a crest or sag?_____

i. Explain answer "h." _____

4-37. Locate Plan and Profile Sheets 11 & 12 *(I-12, Dumplin Creek)* in the Highway Plan Book.

Fill in the blanks below with data regarding **the horizontal curve** (hint: look on the right edge of sheet 11 and left side of sheet 12).

a. Record the Tangent length from P.C. to P.I. _____

b. Record the Station number of P.I. _____

c. Record the Tangent length from P.I. to P.T. _____

d. Record the Bearing of the tangent segment of the highway after P.T.____

e. Record the Bearing **change** between tangent segments of the highway before and after the curve._____

f. Record the Bearing of the tangent segment of the highway before P.C.

_____

g. Record the Length of curvature. _____

h. Record the Radius of curve. _____

4-37. *(continued)*

i. Record the four (4) reference points for P.I., and the distance each is from P.I.

Reference points	**Distance from P.I.**

4-38. When viewing the Plan and Profile sheets it becomes obvious that there are many different symbols used to represent features within the plan.

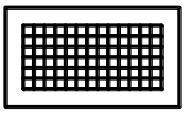
While some symbols represent existing features, others represent proposed construction features.

Topic 4-32 discussed only a few symbols representing drainage structures. Drawn below are additional symbols associated with drainage.

Recall from Chapter 3 Right-of-Ways, **rectangular shaped symbols represent existing buildings**.

Locate Plan and Profile Sheet 14 *(I-12, Dumplin Creek)* in the Highway Plan Book. The shapes of several buildings are visible, as are the driveways.

I-12, Dumplin Creek references Standard Plan number “DR-01(M)” and Standard Plan number “DU-01(M)” to deal with the various construction details associated with different types of driveways.



This is the symbol for a **Catch Basin**. Sometimes notations near Catch Basin symbols state “**REQ’D**” (*required*) an indication of proposed construction (*to be constructed*).

This is the symbol for **Storm Drain Lines**. Notice the arrow indicates the direction of flow.

4-38. *(continued)*

Several catch basin and storm drain line symbols appear on Sheet 35 *(I-12, Dumplin Creek)*.

Reducing the size of the plans sheets makes recognition of the catch basins and storm-drain line arrowheads difficult; however, careful observation of the associated notations coupled with the use of a magnifying glass may help.

4-39. Turn to Plan and Profile Sheet 12 *(I-12, Dumplin Creek)* in the Highway Plan Book. Locate Plan View Station 150 + 00 **east** of the centerline .

Observe the symbol

_____x_____ x_____. It represents an existing fence.

In the same area, there are several additional notes and symbols.
Notice the notes depicting the location of fence corners. A closer look at the notations reveals each post location with respect to the centerline.

- For example, the note on the south corner indicates it is located at Station 149 + 83.1, at a distance of 35.7 feet from the centerline.

Close by, are other notes:

- water meter (WTR MTR),
- gas meter (GAS MTR)
- gates, etc.

4-40. Other symbols representing various objects usually found on the Plan and Profile Sheets are shown below.

Tree: 

Telephone pole: 

Power pole: 

Combination pole: 

Water line _____ W _____ W _____

Gas line _____ G _____ G _____

Sewer line _____ S _____ S _____

Pipeline _____ O _____ O _____

Underground Telephone _____T_____T_____

On occasion, a sheet may have a symbol used incorrectly, or use the wrong symbol to represent an object.

Fortunately, the notations identify the object, clarifying any suspected symbol errors.

4-41. Turn to Plan and Profile Sheet 9 *(I-12, Dumplin Creek)* in the Highway Plan Book. Observe the water lines on each side of the roadway. Look on the east side of the highway; find the gas and underground telephone lines.

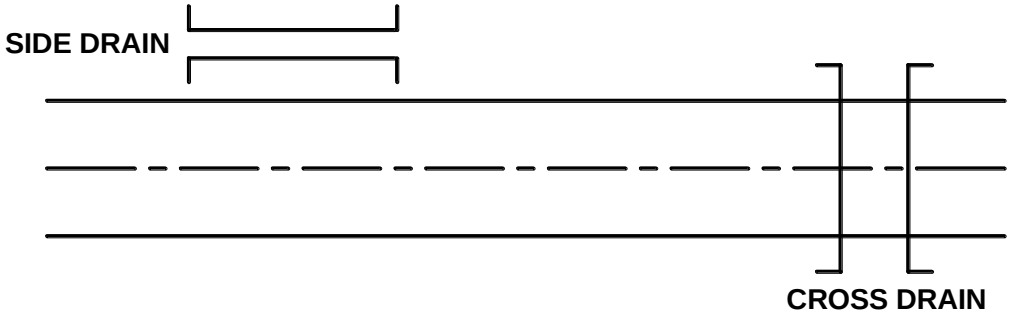
Fill in the blank with the correct answer.

a. What is the size of the water line on the **west** side of the roadway? _____

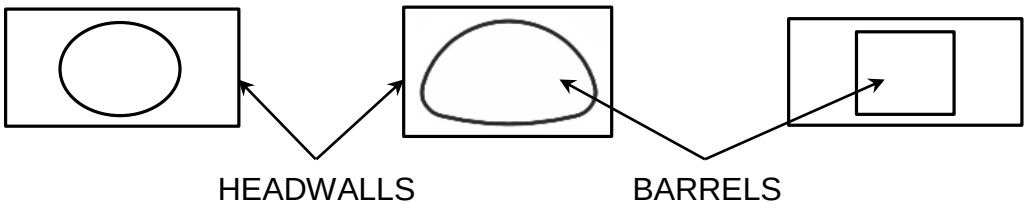
4-42. Turn to Plan and Profile Sheet 38 *(I-12, Dumplin Creek)* in the Highway Plan Book. Locate and carefully study both the Plan and Profile views with regard to the notations concerning the bridge near Station 172+00. Fill in the following blanks with the correct answers.

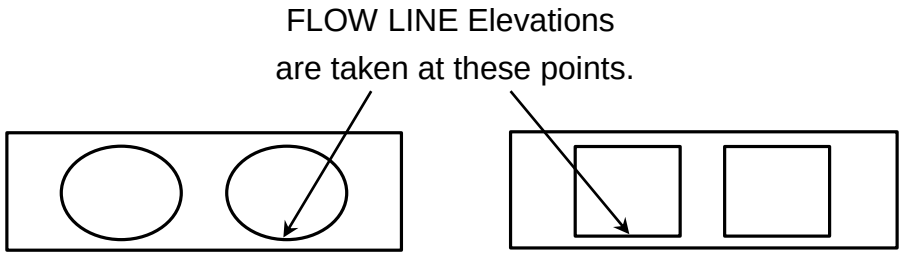
a. What type of bridge is to be removed? _____
b. What type of bridge is required? _____
c. What body of water does the bridge cross? _____
d. How many concrete slab spans are required for this bridge? _____
e. What is the finished grade elevation of the bridge? _____
f. Draw the line used to show the existing bridge. _____
g. At what station does the new bridge begin? _____
h. What is the length of the approach slabs? _____

4-43. A drainage structure carries surface water along the side or across the project. Below are examples of SIDE DRAINS and CROSS DRAINS.



4-44. A CULVERT is a structure with an opening designed to carry water under a roadway or driveway. Below are a few examples of culverts and their components.





Culverts may contain more than one barrel.

4-45. An elevation associated with the lowest point at the end of each structure is the **flow line**, abbreviated **F.L**.

CHAPTER FOUR REVIEW QUESTIONS

4-46. Turn to Plan and Profile Sheet 12 *(I-12, Dumplin Creek)* in the Highway Plan Book. Record the elevation information with regard to the following stations.

	EXIST. Grade	FIN. Grade
a. STA. 146 + 00	_____	_____
b. STA. 152 + 00	_____	_____

4-47. Turn to Plan and Profile Sheet 13 *(I-12, Dumplin Creek)* in the Highway Plan Book. Fill in the blanks provided with the correct information with regard to the **first VERTICAL curve**.

a. Record the percentage Slope before curve. _____

b. Record the percentage Slope after curve. _____

c. Is the curve a sag or a crest? _____

d. What is the Station number at the point of tangency? _____

e. What is the Station number at the point of curvature? _____

f. Record the station number of the vertical P.I. _____

4-48. Turn to Plan and Profile Sheet 14 *(I-12, Dumplin Creek)* in the Highway Plan Book. Fill in the blanks with the correct information with regard to the HORIZONTAL curve beginning on Sheet 14 and ending on Sheet 15 *(hint: Edward J. Dease Jr. ET UX.)*

a. Record the station number of the P.C. (point of curvature) _____

b. Record the station number of the P.I. (point of intersection) _____

c. Record the station number of the P.T. (point of tangency) _____

d. Record the Bearing of the tangent segment before the curve _____

e. Record the Bearing change between tangent segments _____

f. Record the Bearing of the tangent segment after the curve _____

g. Record the Tangent distance between the P.C. and the P.I. _____

h. Record the Tangent distance between the P.I. and the P.T. _____

i. Record the Length of curvature _____

j. Record the Radius of curvature _____

CHAPTER FOUR REVIEW QUESTIONS *(continued)*

4-49. Turn to Plan and Profile Sheet 24 and 24A *(I-12, Dumplin Creek)* in the Highway Plan Book. Utilizing the information found on the sheets, fill in the blanks with the correct information.

List the station numbers associated with the SIDE drains.

a. _____

b. _____

c. _____

d. _____

4-50. Turn to Plan and Profile Sheet 25 *(I-12, Dumplin Creek)* in the Highway Plan Book.

a. How many existing power poles are shown on the south side of the U.S. 190 centerline? _____

4-51. Turn to Plan and Profile Sheet 25A *(I-12, Dumplin Creek)* in the Highway Plan Book. Fill in the blanks with the correct information.

a. An estimated embankment of 990 cubic yards is required between stations _____ and _____.

b. Record the bearing at the centerline of the required bridge_____.

c. Record the F.G. (finished grade) elevation at the center of the bridge.____.

d. The required bridge has a total of _____ slab spans.

4-52. Turn to Plan and Profile Sheet 30 *(I-12, Dumplin Creek)* in the Highway Plan Book.

Locate the culvert under LA 447 at Station 122 + 45. Fill in the blanks with the correct information.

a. Record the Required size(s) and length of this culvert. _____

b. Record the flow line elevations for each end of this culvert.
RT_____ LT_____

4-53. Write T (true) or F (false) beside the following statements.

a. R/W lines are always an equal distance from the centerline. _____

b. Control points on the survey line are tied down with reference points. ____

c. The horizontal scale for the profile view is 1″ = 20′. _____

d. The vertical scale for the profile view is 1″ = 5′. _____

4-54. Draw the symbols representing:

a. A fence:

b. A water line:

c. A gas line:

4-55. What do each of these symbols represent? Use the blanks provided

a. _____ 

b. _____ 

c. _____ 

d. _____ 

e. _____ _____ **T** _____ **T** _____

f. _____ _____ **G** _____ **G** _____

g. _____ _____ **O** _____ **O** _____

h. _____ _____ **S** _____ **S** _____

i. _____ _____**W**_____**W**_____

4-56. In the blanks provided, write the descriptions for the follow abbreviations.

a. _____ 6d N & C

b. _____ TBM

c. _____ RT

d. _____ PVI

e. _____ BM

f. _____ F.L

g. _____ P.T.

h. _____ WTR MTR

i. _____ R.C.P.A.

***Note**: Check your responses against answer sheets found at the end of this manual. If you missed MORE than three questions, review this chapter again and correct any wrong answers before progressing.*

TRAINING NOTES

CHAPTER 5
CROSS-SECTION SHEETS

INTRODUCTION

Chapter 5 explores the highway from yet another vantage point. Whereas the longitudinal cross-section (*Profile View from Chapter 4*) dealt with the length of the highway, it is also important to view the CROSS-SECTION width or transverse (across) the highway. Cross-sections enable the plan reader to observe the existing ground line, and proposed grade line "across" the highway.

CROSS-SECTION drawings illustrate with detail, the proposed shape of the project across the highway at specific station intervals. Computations with regard to "Cut and Fill" earthwork are also recorded at each station.

Although the Index on Sheet 1 of State Project H. 000238 (*Drain Canal Bridges on U.S. 90*) indicates the existence of Cross-Section sheets 401-405, the drawings on them only offer a small amount of detail. Whereas the Cross-Section sheets found in the plan set of State Project, 268-01-0012, I-12 – DUMPLIN Creek offer clear-cut, uncomplicated details beneficial to this course.

Open the Highway Plan Book, locate the Title Sheet for the State Project I-12 – DUMPLIN Creek, and find the Index to Sheets. Note the Cross-Section sheets for this project are 401- 443, several of which are included in the Highway Plan Book. Review these sheets before progressing.

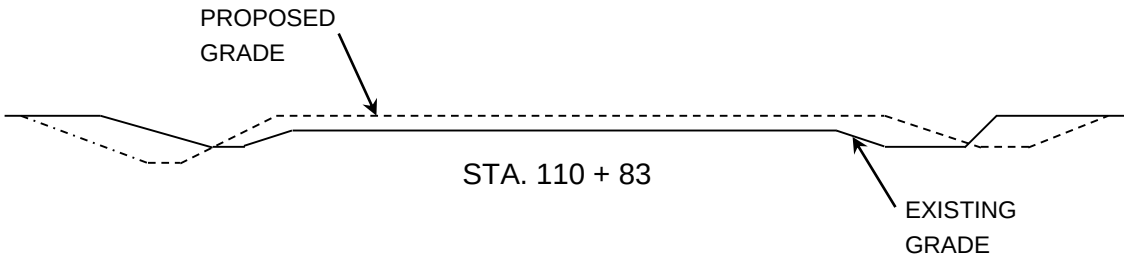
NOTE: It is possible that the reduced size of the Cross-Section sheets has made some of the information on the sheets difficult to read. Use of a straight edge (ruler) and a magnifying glass will be beneficial.

Throughout the chapter, consecutive **TOPIC** numbers indicate various facets of information pertaining to Cross-Section sheets. Occasionally, topic numbers will reference one another.

As in the previous chapter, review questions relating to the subject information appear periodically. Complete each question, as they will become useful study guide material.

SHEET LAYOUT

5-1. Below is an example of a typical cross-section as seen on a Cross-Section Sheet.



The **solid line represents the existing grade** while the **dashed line represents the proposed (new) grade.** Occasionally, light lines represent the existing grade while a heavy line represents the proposed (new) grade.

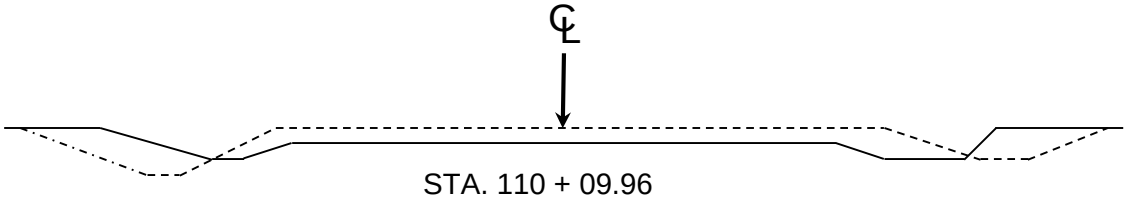
Refer to the drawing above; fill in the blanks with the correct answer.

a. Dashed lines represent the _____ grade.
b. Solid lines represent the _____ grade.

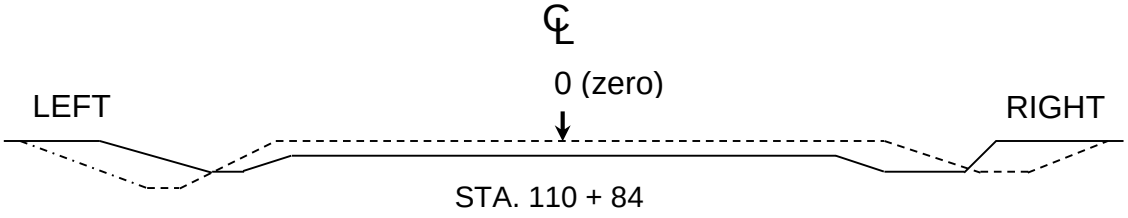
5-2. Cross-Section sheets are read from **bottom to top**. The first **cross-section drawing** of the project is at the **bottom** of the first Cross-Section Sheet, the next cross-section drawing is above the first, and so on.

5-3. Open the Highway Plan Book, locate Cross-Section sheet 401 *(I-12, Dumplin Creek);* it is the first cross-section sheet. Observe that each cross-section drawing has a corresponding station number, **beginning with the lowest station number at the bottom**.

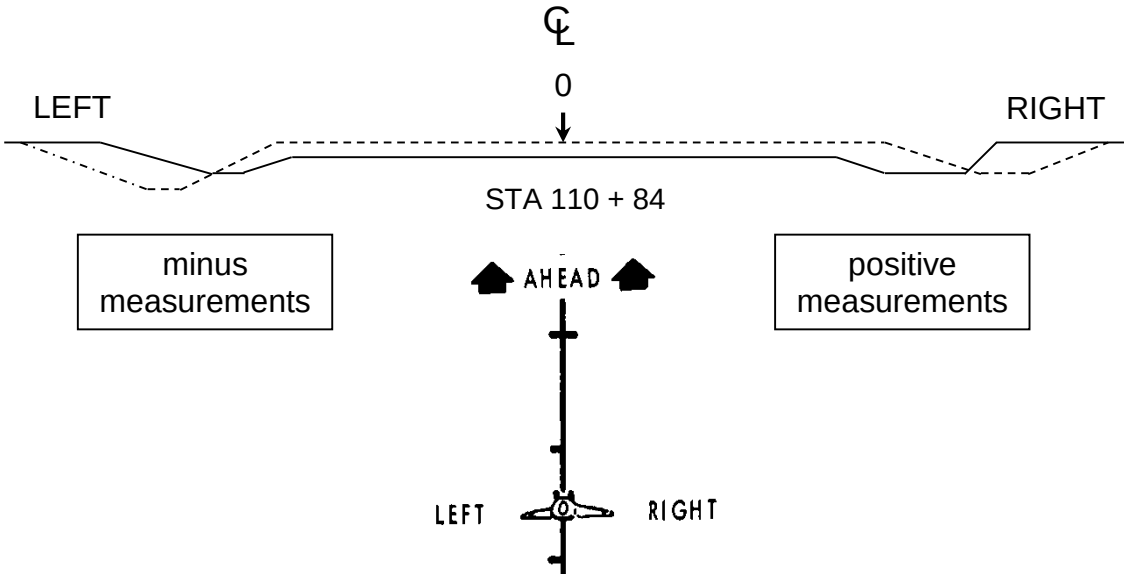
5-4. Look at Station 110 + 09.96 located at the bottom of Cross-Section sheet 401 *(I-12, Dumplin Creek)*. **An arrow indicates the centerline ℄ of the roadway**; it is the same for all cross-section drawings on each Cross-Section sheet.



5-5. With regard to measuring, the centerline has a value of "0" (zero) and represents the starting point for all horizontal measurements. Measurements start at the centerline and extend to the left or right.



5-6. Recall the "outstretched arms" from topic 1 in chapter 4. A similar situation occurs when reading the horizontal scale associated with cross-section drawings.



Look at the cross section drawings on sheet 401, with the centerline at "0" (zero,) the department considers the left side of each cross-section drawing the "left side" of the highway and it is associated with minus numbers on the horizontal scale. Conversely, the right side of each cross-section drawing is the "right side" of the highway and is associated with positive numbers on the horizontal scale.

LEFT SIDE = MINUS NUMBERS

RIGHT SIDE = POSITIVE NUMBERS

To grasp the concept, imagine standing on the centerline looking ahead, up the Sheet (*see the illustration above*.) Each cross-section drawing changes slightly as the station numbers increase from the bottom to the top of each sheet.

5-7. Fill in the blanks with the correct answer with regard to the previous topics.

a. A(n) _____ indicates the centerline of the roadway.

b. The _____ of the project is at the bottom of the first Cross-Section Sheet.

c. Key to interpreting a Cross-Section sheet requires reading the sheets from_____.

d. Each cross-section drawing has a _____ and they begin with the lowest station number at the bottom.

e. The left side of each cross-section drawing is the _____of the highway and is associated with _____numbers on the horizontal scale.

f. The right side of each cross-section drawing is the _____of the highway and is associated with _____numbers on the horizontal scale.

g. Each cross-section drawing changes slightly as the station numbers _____ from the bottom to top of each sheet.

h. With regard to measuring, the centerline has a value of _____and represents the _____ point for all horizontal measurements.

i. Measurements start at the _____and extend to the _____or _____.

5-8. For the most part cross-section drawings appear at 100 feet intervals along the project, with additional cross-sections drawn in-between as situations warrant.

Record the station numbers for the cross-sections shown on sheet 401 *(I-12, Dumplin Creek)*.

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

SCALES ASSOCIATED WITH CROSS SECTION SHEETS

5-9. Open the Highway Plan Book, locate the Cross-Section sheets 401 - 403 *(I-12, Dumplin Creek)*. Observe that Cross-Section sheets look like large pieces of graph paper.

It is a little difficult to see, but notice that every 10th line, whether horizontal or vertical, appears heavier (darker/thicker) than the other lines.

Most of the time the distance between the heavy vertical and horizontal lines on Cross-Section Sheets is 10 feet. Although a quick look at Cross-Section sheet 402, *(Drain Canal Bridges on US 90)* shows that the distance can also be 5 feet.

Here is an easy way to determine the distances between the heavy vertical and horizontal lines.

- When the numbers listed along the bottom or sides are multiples of 5, the distance between the heavier (darker/thicker) lines is interpreted as 5 feet.
- Likewise, when the numbers listed along the bottom and sides are multiples of 10, the distance between the heavier (darker/thicker) lines is interpreted as 10 feet.

5-10. When reading cross-section sheets, two scales apply, **vertical and horizontal**.

Here is the scale notation listed along the bottom of Cross-Section sheet 401, *(I-12, Dumplin Creek)*.

H = 1 inch = 10.0 feet (or Horizontal: 1″ = 10.0 feet)
V = 1 inch = 10.0 feet (or Vertical: 1″ = 10.0 feet)

Remember that the Plan Set sheets for this course are reduced in size, and are Not-to-Scale (NTS). Presently, our concerns deal with **READING** the Plan Sheets, not measuring.

To accurately **read and interpret** Cross-Section sheet 401 *(I-12, Dumplin Creek)*, remember that:

- 10 lightly drawn lines separate the heavy vertical and horizontal lines, each at a 1-foot interval.
- Every 10th line is “heavier and darker,” indicating a distance of 10 feet.

Note: *If the Cross-Section Plan Sheets were full size (to scale), and we measured using the Engineer scale “10” (interpreting it as 1"=10) it would clearly indicate that the heavier, darker lines are 10 feet apart, and that 10 lighter lines in-between measure 1 foot apart.*

5-11. A good way to read and interpret measurements on Cross Section Sheets is to count the dark (heavy) and light (thin) lines, as measuring distances on a Cross-Section Sheet usually does NOT require a scale.

Refer to Cross Section sheet 401 *(I-12, Dumplin Creek)*.

- Observe that whether vertical or horizontal, 10 smaller squares appear between the heavier lines.
- On this reduced-size sheet, each SMALL square equals one foot vertically, and one foot horizontally.
- Horizontal measurements are for distances **across** the highway.
- Vertical measurements give **elevations** for each cross-section.

Answer the following questions; write the correct answer in the blank.

a. Ten SMALL squares across (horizontal) equal _____.

b. Horizontal measurements give the distances _____ the highway.

c. Vertical measurements give the _____ of the highway.

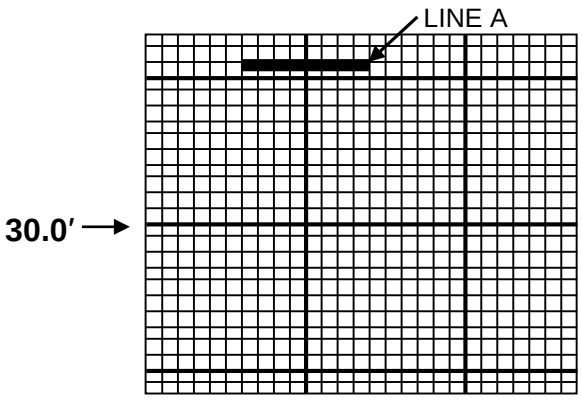
d. Twelve (12) SMALL squares across (horizontal) equal _____.

e. Seven (7) LARGE squares across (horizontal) equal _____.

f. Two (2) LARGE squares up and down (vertical) equal _____.

g. Four (4) SMALL squares up and down (vertical) equal _____.

5-12. On the right is an illustration taken from a Cross-Section Sheet. It is not drawn to scale.



Notice one heavier (*darker/thicker*) horizontal line has an elevation of 30 feet

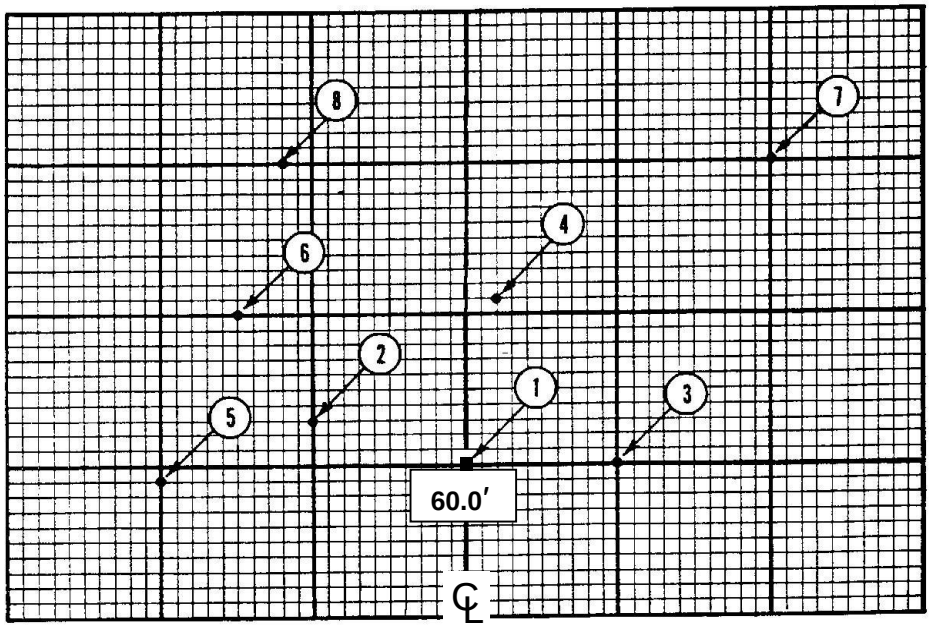
Remember, the distance between the heavier (darker) lines, whether horizontal or vertical, equals 10 feet.

Answer the following questions with regard to illustration.

a. Record the elevation of the line A. _____

b. Record the length of the line A. _____

5-13. Below is another illustration of a Cross-Section Sheet, it is **not** drawn to scale.



From the illustration above:

- **Point 1** is located **on the centerline** and has an **elevation of 60.0 feet**.
- **Point 2** has an **elevation of 63 feet** and is **10 feet left of the centerline**.

5-14. Refer to the information and illustration from topic 13; identify the location of the unknown points.

a. **Point 3** has an elevation of _____ feet and is _____ feet _____ (*left or right*) of the centerline.

b. **Point 4** has an elevation of _____ feet and is _____ feet _____ (*left or right*) of the centerline.

c. **Point 5** has an elevation of _____ feet and is _____ feet _____ (*left or right*) of the centerline.

d. **Point 6** has an elevation of _____ feet and is _____ feet _____ (*left or right*) of the centerline.

e. **Point 7** has an elevation of _____ feet and is _____ feet _____ (*left or right*) of the centerline.

f. **Point 8** has an elevation of _____ feet and is _____ feet _____ (*left or right*) of the centerline.

CROSS-SECTIONS

5-15. Open the Highway Plan Book, locate Cross-Section sheet 401, *(I-12, Dumplin Creek)*. Examine the **first** cross-section drawing at the bottom of the sheet. Remember the dashed lines signify the proposed or new grade, and the solid line depicts the original ground or existing grade.

- Identified with an arrow on the left and right sides of the roadway is the Right of Way (ROW)
- Written below the grade line, near the centerline, is the station number for this cross-section.
- Written above the grade-line is the elevation for this cross-section.

5-15. *(continued)*

Refer to cross-section drawings located on Cross Section sheet 401, *(I-12, Dumplin Creek)*. Record the correct answers in the blanks provided. Use of a straight edge (ruler) and a magnifying glass will be beneficial.

a. The elevation and the station number reference the original ground line at the_____ of the roadway.

b. The solid line represents. _____

c. Record the station number for the cross-section located at the top of Sheet 401._____

d. Record the elevation of the existing grade for the cross-section located at the bottom of Sheet 401._____

e. How many cross-sections are drawn on sheet 401? _____

f. Each small vertical square is equal to _____.

g. Record the elevation of the **present ground** at Station 112 + 00._____

h. Record the elevation of the **proposed grade** at the centerline of Station 110 + 83. _____

i. What is found 97 feet left of the centerline at Station 112 + 17?_____

j. Record the distance to the RIGHT R/W, from the centerline of Station 110 +09.96 _____

k. At Station 112 + 24, is the proposed grade higher or lower than the original ground? _____

EARTHWORK

Notations along the right side of Cross-Section sheet 401, *(I-12, Dumplin Creek)* indicate the calculated totals of the required cut and fill.

Remember from previous topics; **excavating earth (removal) is "Cut**," while the opposite, **adding earth, is "Fill"** (*i.e. embankments*).

The notations give quantities of earthwork in terms of **cubic yards**. These quantities apply to the portion of the project between the cross-section stations.

For example, on Sheet 401, *(I-12, Dumplin Creek),* at the top of the Cut and Fill columns, observe that 47 cubic yards of excavation (cut) take place between Stations 112 + 17 and 112 + 24.

5-16. Locate Cross Section sheet 402 *(I-12, Dumplin Creek))* in the Highway Plan Book, refer to the Cut and Fill notations. Record the correct answer in the blank provided.

a. How many cubic yards of cut occur between Stations 113 + 00 and 114 + 00?_____

b. How many cubic yards of fill are required between Stations 112 + 91 and 112 + 96?_____

CHAPTER 5 REVIEW QUESTIONS

5-17. Utilize Cross-Section sheet 403 in the Highway Plan Book *(I-12, Dumplin Creek)* Fill in the blanks with the correct answer.

Observe the **proposed ditch** located on the **left** side of the roadway centerline, close to the R/W. Record the **approximate** elevation at the **bottom of the ditch** for the following stations.

a. Station 118 + 00 (left side) _____

b. Station 115 + 00 (left side) _____

c. Station 120 + 00 (left side) _____

5-18. Record the approximate elevation of the original ground line for Station 118 + 00 at the following locations.

a. At the centerline _____

b. 40-feet left of the centerline _____

c. 32-feet right of the centerline _____

d. 65-feet right of the centerline _____

e. 10 feet right of the centerline _____

5-19. Record the approximate distance from the centerline to each R/W line at Station 117 + 00.

a. Left side _____

b. Right side _____

5-20. How many calculated cubic yards of **CUT** occur between each of the following cross sections?

a. Stations 116 + 00 and 117 + 00 _____

b. Stations 119 + 00 and 120 + 00 _____

CHAPTER 5 REVIEW QUESTIONS *(continued)*

5-21. How many calculated cubic yards of **FILL** occur between each of the following cross sections?

a. Stations 116 + 00 and 117 + 00 _____

b. Stations 115 + 00 and 116 + 00 _____

5-22. Recall the vertical and horizontal scales associated with Cross-Section sheet 401, *(I-12, Dumplin Creek).*

a. HORIZONTAL: 1″ = _____

b. VERTICAL: 1″ = _____

***Note**: Check your responses against answer sheets found at the end of this manual. If you missed MORE than three questions, review this chapter again and correct any wrong answers before progressing.*

TRAINING NOTES

CHAPTER 6
TYPICAL SECTIONS AND DETAILS SHEETS

INTRODUCTION

Previous chapters discussed plan, profile and cross-section views with regard to subgrade details, and the location of a project. This chapter reveals more specifics about the actual construction of proposed projects. Reading plans or inspecting construction work requires knowledge of the specific details found in **Typical Sections and Details Sheets**.

Construction details on Typical Sections and Details Sheets are the same ***(typical)*** for most locations along the project.

Typical Sections and Details Sheets illustrate construction DETAILS of the ROAD **above the SUBGRADE.** These sheets are used in conjunction with the Plan, Cross-Section, and Profile Views.

This chapter will reference material from State Project H. 000238 (*Drain Creek Bridges on U.S. 90*), State Project, I-12 – Dumplin Creek, and others.

Open the Highway Plan Book, locate the Title Sheet for the State Project H. 000238, and find the Index to Sheets. Notice that only one sheet of "Typical Sections and Details Sheets" is listed, it is sheet 2. Turn to sheet 2 and review the drawings.

Now find the Title Sheet for State Project I-12 – Dumplin Creek in the Highway Plan Book, notice the Index to Sheets records sheets 2-2h as containing information drawn on "Typical Sections and Details Sheets." A few sheets are included in the Highway Plan Book; locate State Project I-12 – Dumplin Creek "Typical Sections and Details Sheets" sheet 2, and review the drawings before progressing.

As in the previous chapter, review questions relating to the subject information appear periodically. Complete each question, as they will become useful study guide material.

GENERAL NOTES

6-1. General notes on Typical Sections and Details Sheets contain instructions for the contractor and the inspector.
Here is an example of a ***typical*** note:

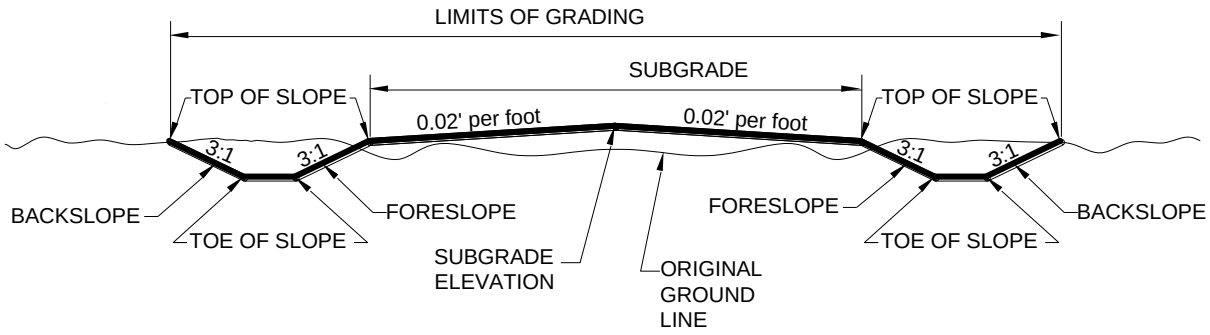
> **NOTE**:
> Drawings are not to scale.
> The section to be used at any particular location shall be as shown on cross-sections, unless otherwise directed by the Project Engineer. All dimensions shown are design dimensions and will be followed to the nearest practical limits in the field as determined by the Project Engineer, if tolerances are not otherwise specified.

Read the statements listed in the table shown below. Refer to the ***typical*** note above, and then determine if the statement is true or false. Place a circle around the T for true or F for false.

a.	Contractors are allowed to choose which sections to use at each specific location (stations.)	T	F
b.	Dimensions are to scale.	T	F
c.	The dimensions used in the field must be the same as the design dimension.	T	F
d.	The Project Engineer can change the cross-section if necessary.	T	F
e.	A line representing 2 feet will always be twice as long as a 1 foot line.	T	F
f.	The Contractor sets tolerances in the absence of the Project Engineer	T	F

TYPICAL GRADING SECTIONS

6-2. Chapter 5 introduced cross sections on Cross-Section sheets. Below is a similar illustration of a Cross-Section View associated with the **grading** features found on "Typical Sections and Details Sheets." Review the details and the terminology.



6-3. Almost all road plans have **RATES OF SLOPE**. Chapter 4 introduced "percentage slopes" in the profile view. There are other ways to express Rate of Slope; this chapter presents additional views and methods.

6-4. Listed below are the three primary methods used to express RATE OF SLOPE.

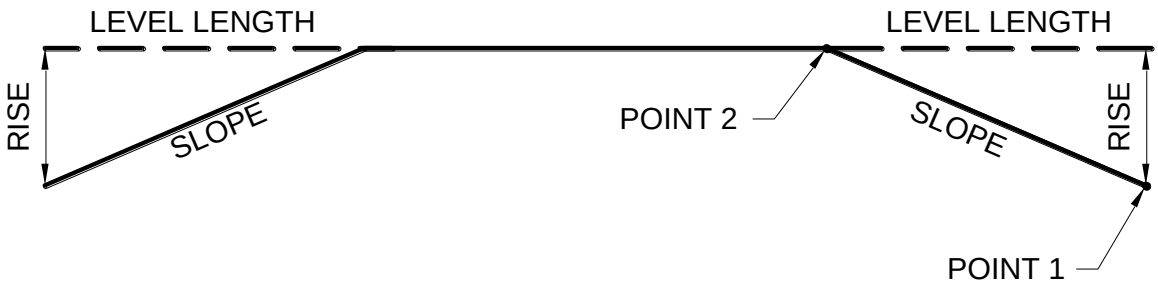
- Decimal of foot per foot - 0.015′ per foot (.015 $^{I}/_{I}$ or .015 $^{Ft}/_{Ft}$)
- Percent - 0.26%
- Ratio - 4:1

6-5. Here are two reasons why accurate interpretation of the "Rate of Slope" is important.

- To calculate the elevation of any point on a given slope, with regard to any other point on the same slope.
- To compare slopes when the rate of slope is expressed in different ways. e.g. 5:1 or 20%.

6-6. Determining slope of a road (*"steepness" of an incline*) is the **RISE** for a given **LEVEL LENGTH** (run) of the road.

Observe the illustration below; the RISE is the difference in elevation between Points 1 and 2.



Refer to the right side of the diagram above:
Given:

- a level length *(run)* of 1 foot
- the **elevation** of Point 1 is 25 feet
- the **RISE** from Point 1 to Point 2 is 20 feet

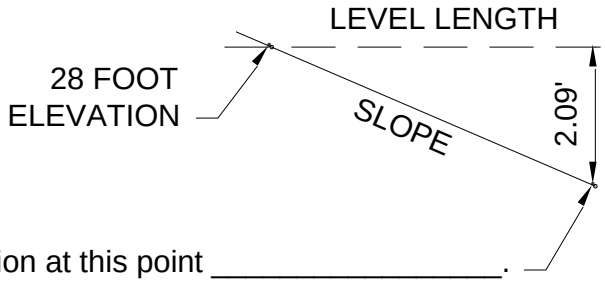
In this example, there is a rise of 20 feet for every 1 foot of level length. Adding 25′ + 20′ equals 45′. The elevation of Point 2 is 45′.

Conversely, if the elevation of Point 2 is 45 feet, and the RISE from Point 1 to point 2 is 20 feet, with a level length of 1 foot, then the elevation of Point 1 must be 25 feet (45′- 20′ = 25′.)

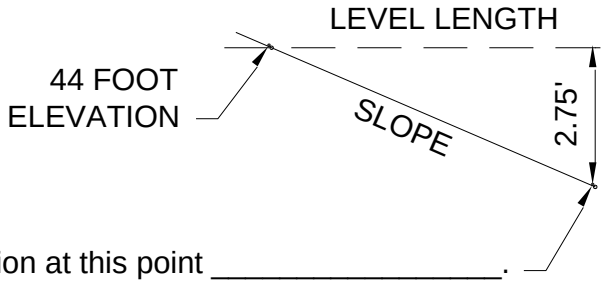
Just adding or subtracting the RISE obtains the unknown elevation when the level length is 1 unit.

6-7. Each diagram below shows two points on a sloping line. One point has a given elevation, while the other remains unknown. A dimension refers to the difference (rise) in elevation between the points.

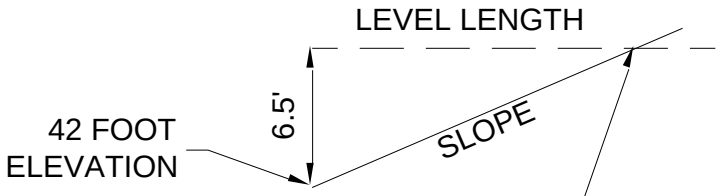
In the blanks provided, calculate, and record the correct elevation for the unknown point. For this exercise, all of the dashed lines have the same level length (run) of 100 feet.



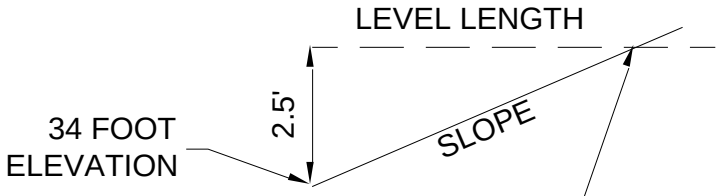
a. Calculate the elevation at this point _____.



b. Calculate the elevation at this point _____.



c. Calculate the elevation at this point _____.



d. Calculate the elevation at this point _____.

6-8. To determine the **RISE**, multiply the Level Length by the Rate of Slope, making sure to express **both** the **level length** and the **rate of slope** in **FEET**.

RISE′ = Level Length (in feet) X Rate of Slope (in feet)

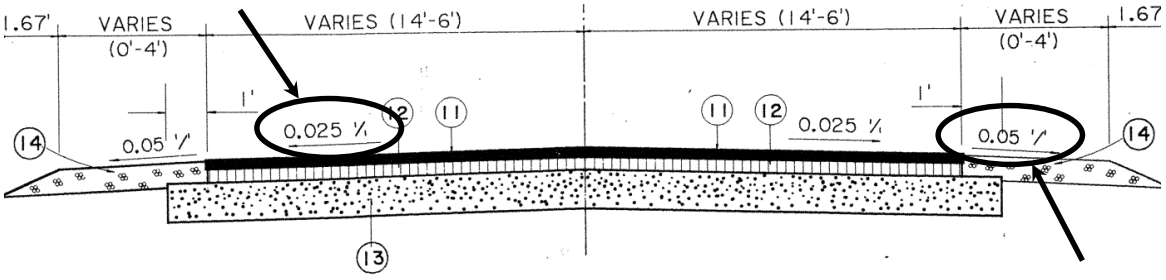
Example: RISE′ = 10′ (Level Length) X 0.15′ (Rate of Slope)
RISE′ = 10′ X 0.15′
1.5′ = 10′ X 0.15′
RISE = 1.5′

6-9. Earlier, topic 3 discussed different ways to determine Rate of Slope, first was "**decimal of foot per foot**," (e.g. 0.015′ per foot.)
This decimal number is the rise (in feet) per foot of level length.
A typical section may show it as 0.015 $^{1}/_{1}$ or 0.015 $^{Ft}/_{Ft}$.

Subgrades on typical sections often use this format, as do slopes found on "Super-elevation" drawings.
Care is to be taken when reviewing plan sets, as they are sometimes difficult to read, making it easy to mistake $^{1}/_{1}$ for %.

Open the Plan Book to the typical sections shown on Sheet 2a, (*I-12, Dumplin Creek*.) Notice that each typical section shows 0.025 $^{1}/_{1}$, which can be easily mistaken for 0.025%.

The drawing below is from a portion of a Typical Finished Section found on Sheet 2a, (*I-12, Dumplin Creek*.)

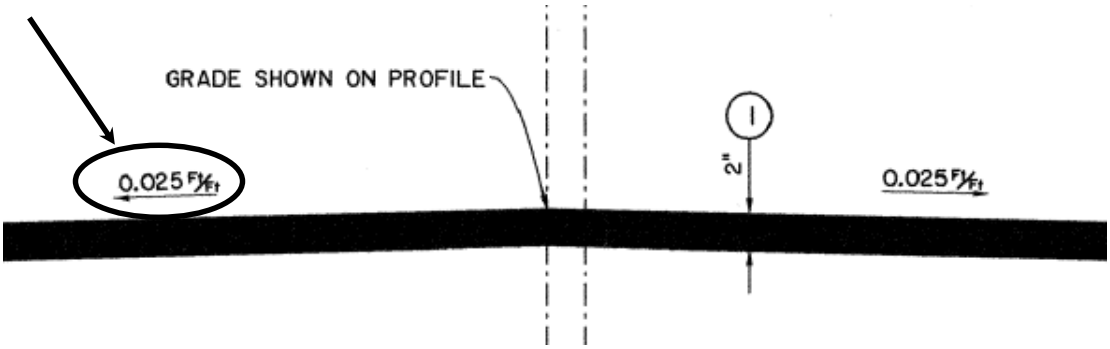


SECTION A-A
TYPICAL FINISHED SECTION

6-9. *(continued)*

Shown below is a portion of a typical section from a newer DOTD plan set, it is from Sheet 2, H.007120 *Parish Road* (*Eva to Ruth*.)

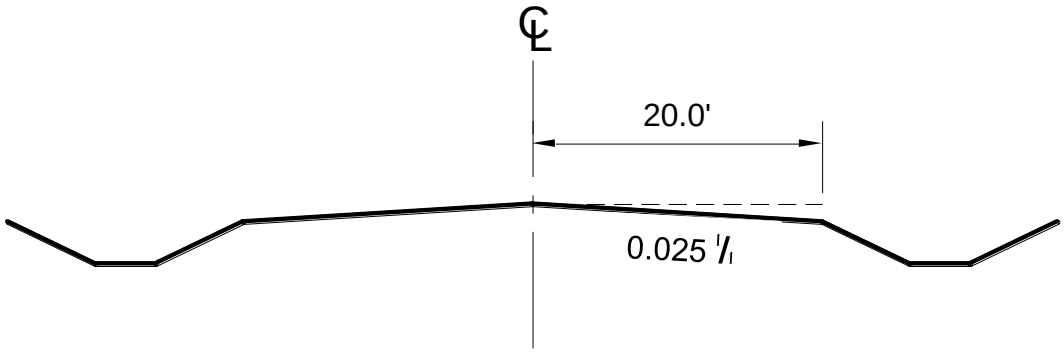
Notice it clearly indicates a slope of 0.025 $^{Ft}/_{Ft}$.



Refer to the table below; given the level lengths and "***decimal of foot per foot***" slope, calculate the **RISE,** record the correct answer in the blank provided. Follow the example shown in the first row.

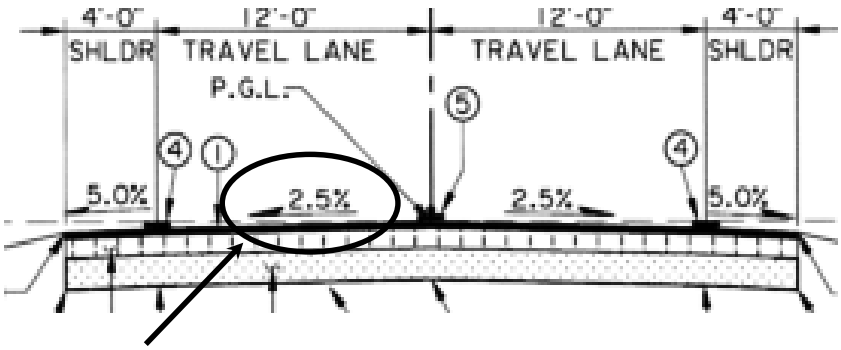
	LEVEL LENGTH	SLOPE RATE	**RISE**
Ex.	10′	0.015 $^{I}/_{I}$	**answer = .15′**
a	20′	0.010 $^{I}/_{I}$	
b	10′	0.05 $^{I}/_{I}$	
c	30′	0.015 $^{Ft}/_{Ft}$	

6-10. Here is a cross-section view of a roadway



a. Calculate the elevation at the top of the right fore-slope._____

6-11. The second way of expressing slope is with a **percentage,** e.g., 2.5 %.
Shown below is part of the typical section taken from State Project H. 008244. Open the Highway Plan Book to Sheet 2e, H. 008244.
Notice the slopes are percentages (**%**.)



Calculating RISE per foot of level length starts by converting "percentage slopes" to decimal feet, this is done by moving the decimal point two places to the left, or dividing the percentage by 100.

- for example, 2.5% is a slope of **2.5% per foot**.
- remember, 2.5% is $^{2.5}/_{100}$ per foot

and $^{2.5}/_{100}$ per foot can be converted to 0.025 per foot

Here is another example:

When given a slope of 3.0%, moving the decimal point two places to the left, makes the RISE = 0.030 per foot of level length.

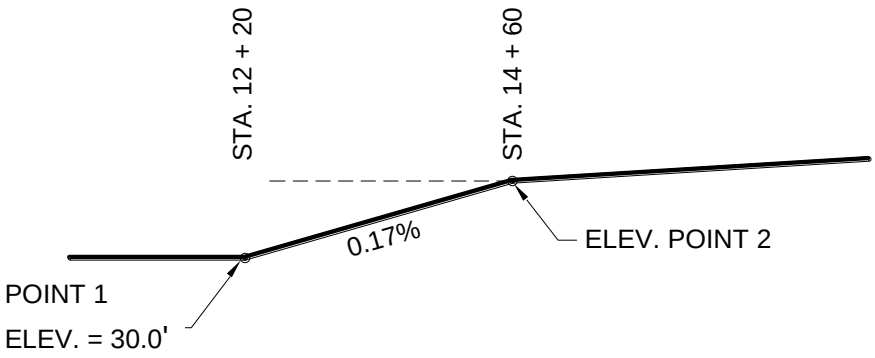
Refer to the table below; given the level lengths and "**percentage slopes**," calculate the **RISE,** record the correct answer in the blank provided. Remember, expressing the rise in feet requires converting the percentages to "*decimal*" form. Follow the example shown in the first row.

	SLOPE RATE	LEVEL LENGTH	**RISE**
Example	0.15% (0.0015)	10′	**answer = 0.015′**
a	0.16%	30′	
b	0.30%	20′	
c	0.25%	40′	

6-12. Shown below is the partial profile view of a grade with a percentage slope."

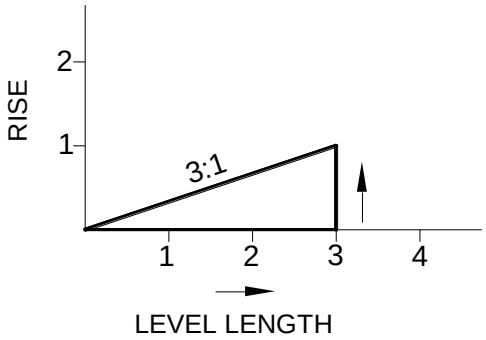
a. Calculate the **level length** between the station numbers. _____

b. Calculate the elevation at POINT 2. _____



6-13. A third way of expressing a slope is **ratio** (e.g. 3:1,) fore-slopes and back-slopes use this format. A good way to recall how a ratio expression works is to remember that ***the first number is always the level length, and the next number is the rise***.

For example, take the ratio 3:1, there are three (3) units of level length for every one (1) unit of rise. See the illustration below.



Calculating RISE per foot of level length starts by converting the **ratio** to a decimal or a fraction, this is done by dividing the first number into the second.

Example: **4:1** = 1/4 = $4\overline{)1.000}$ (.25) or 0.25

The decimal rise is 0.25′ or 1/4′ per foot of level length

6-13 ***(continued)***

Remember, **Rise in feet = Level length in feet X Slope Rate**

Here is another example.

To calculate the RISE for a 10′ level length distance and a 5**:**1 slope, start by converting the slope rate to decimal or fraction form, then multiply it by the level length.

Slope Rate = 5**:**1 or **0.20** or Slope Rate = 5**:**1 or $\frac{\mathbf{1}}{\mathbf{5}}$

Rise in feet = **10′** X 0.20 or Rise in feet = **10′** X $\frac{1}{5}$

Rise = 2.0′ **Rise =** $\frac{10}{5}$ **= 2.0′**

Remember, expressing the rise in feet requires converting the ratio to decimal or fraction form. Refer to the table below; given the level lengths and "**ratio slopes**," calculate the **RISE,** record the correct answer in the blank provided.

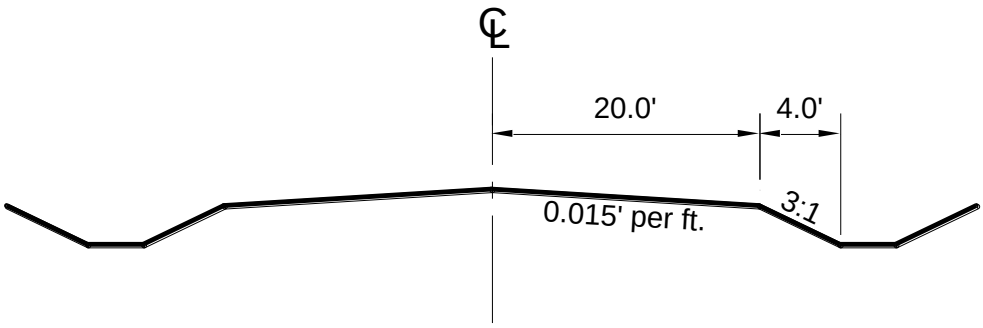
Follow the example shown in the first row.

	RISE	LEVEL LENGTH	SLOPE RATE
Example	**answer = 2.0′**	10′	5:1 (or 0.20)
a.		30′	4:1
b.		20′	3:1
c.		40′	2:1

6-14. Refer to the illustration below, complete the following questions, and record the correct answer in the blank.

a. Calculate the elevation at the **TOP** of the "fore-slope." _____

b. Calculate the elevation of the **BOTTOM** of the "ditch." _____



STA. 21+00 SUBGRADE ELEV. 22.0'

6-15. Previous cross-sections in the plan set gave limited information about roadway grades; "**Typical Grading Sections**" reveal additional details with regard to "grading."

Turn to the Typical Sections and Details - Sheet 2 *(I-12, Dumplin Creek) in* the Highway Plan Book.
Typical **Grading** Sections are often divided into two parts, due to space constraints.
Observe that the right side of the Typical Grading Section drawing reveals "**cut**" details, while the portion of the drawing **left** of the centerline reveals "**fill**" details.

At the top of the sheet, find the "**ground line**" symbol, it is located on the right side of the Typical Grading Section.

Notice the Typical Grading Section shows grading dimensions **below** the existing ground line, further indicating this section is a cut.

6-15 *(continued)*

Remember,

"Cut" = earth removed
"Fill" = earth placed

Use the "Typical Grading Section" on sheet 2 *(I-12, Dumplin Creek)* in the Highway Plan Book, and the information from topic 6-2 to answer the following question.

a. Calculate the difference in elevation between the "toe of slope" and the "top of slope." Use the 10′ minimum level length distance *(right side of drawing.)* _____

6-16. Plan and Profile Sheets show the **finished grade elevations** in the profile view, while the Typical Grading Section shows the **subgrade elevations** *(Cross-Section Sheets also show the **subgrade elevations**.)*

To determine the centerline elevation at a specific location for a Typical Grading Section, refer to that station on the Cross-Section sheet. The elevation can also be calculated by finding the finished grade elevation from the appropriate Plan and Profile sheet, then subtract the combined thickness of the surface course(s) and base course.

6-17. Look at Typical Grading Section on Typical Sections and Details Sheet 2 *(I-12, Dumplin Creek)*. A dashed horizontal line represents the finished grade as indicated on a corresponding Profile *(Plan and Profile Sheet)*. In this case, the difference between the finished grade and subgrade elevations is the combined thickness of the concrete pavement and base course (14 inches or 1.17 feet).

Notice that a **Legend** on the right side of Sheet 2 shows the thickness of the concrete pavement and base course.

Fill in the blanks on the next page with the correct answer.

6-17 ***(continued)***

a. Typical Grading Sections show a _____ representing the finished elevation

b. To find the centerline elevation at a specific station of a typical grading section, look on the corresponding _____ sheet.

c. Plan and Profile Sheets show the _____ elevation.

6-18. Natural *(original)* ground is usually unsuitable for placing roadway–building materials. Carefully planned specifications determine the appropriate modification methods needed to turn it into a suitable subgrade layer. Earlier, the Cross-Section sheets clarified the need for cut, fill, or sometimes both. Because these modifications change the natural elevation, it is important that the final thickness of the subgrade layer match the elevation as indicated on the plans.

Refer to the Legend located on sheet 2 *(I-12, Dumplin Creek)***, "Typical Grading Section" in the Highway Plan Book; answer the following questions.**

a. How thick is the subgrade layer? _____

b. The LEFT side of the Typical Grading Section shows how to contour the subgrade for a _____situation. (cut or fill)

c. The RIGHT side of the Typical Grading Section shows how to contour the subgrade for a _____situation. (cut or fill)

d. A _____ is indicated for drainage in the CUT section.

e. The Typical Grading Section shows slopes at the centerline; is the slope the same for the cut and fill sections? _____

f. Record the slope of the CUT Fore-slope. _____

g. Record the slope of the CUT Back-slope. _____

h. Record the slope of the subgrade on the RIGHT side of the travel lane.____

i. Record the slope of the subgrade on the LEFT side of the travel lane._____

j. The LIMITS OF SEEDING AND FERTILIZER extend to the _____.

k. Determine the **elevation drop** between the top and bottom of the fore-slope if the fore-slope in the fill section is 6 feet wide. _____

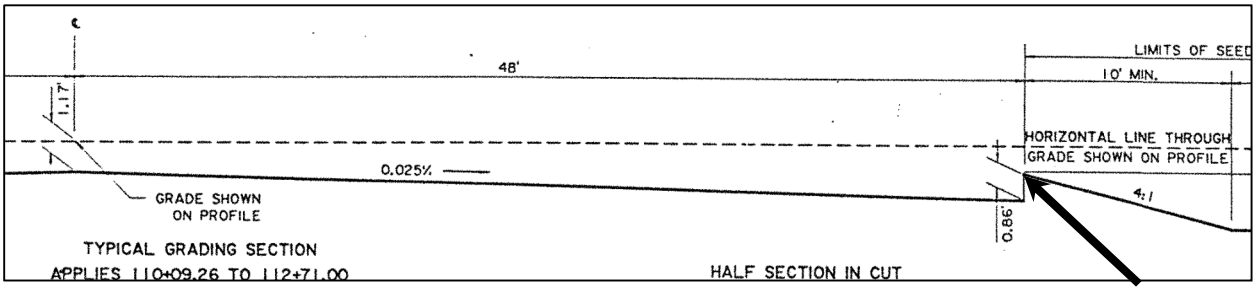
l. What is the width of the bottom of the ditch on the cut side?_____

6-19. Notice that the Typical Grading Section on sheet 2 *(I-12, Dumplin Creek)* in the Highway Plan Book relates to the locations between stations 110 + 09.26 and 112 + 71.00.

Fill in the blanks with the correct answer. Use the information on the Typical Grading Section **and any other corresponding sheets** as necessary.

a. Approximate the **finish** grade elevation at the centerline of the Section at station 110 +83. (*Hint: Look on the corresponding Plan and Profile sheet or Cross-Section sheet)* _____

b. At station 110 + 83, calculate the elevation at the top of the fore-slope the on the right side of the section.



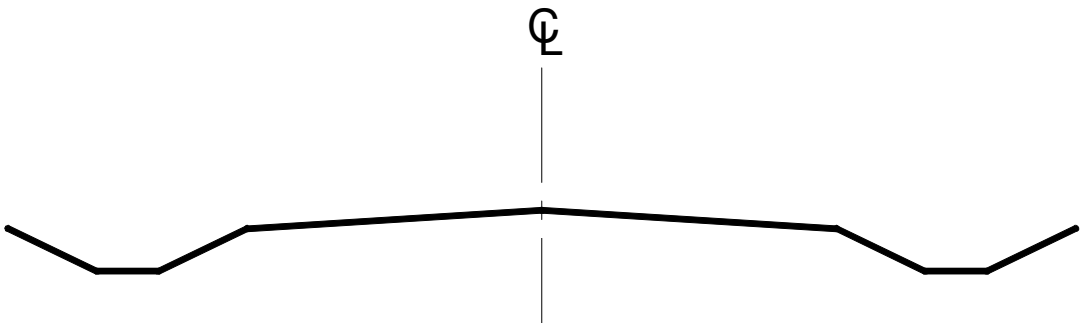
*(Hint: The arrow points to the top of the fore-slope. Use the answer from question "**a**" & the dimensions shown on the Typical Grading Section, adding and subtracting as necessary)* _____

c. At station 110 + 83, what is the approximate distance for seeding and fertilizer at this station? (*Hint: Look on Sheet 401*) _____

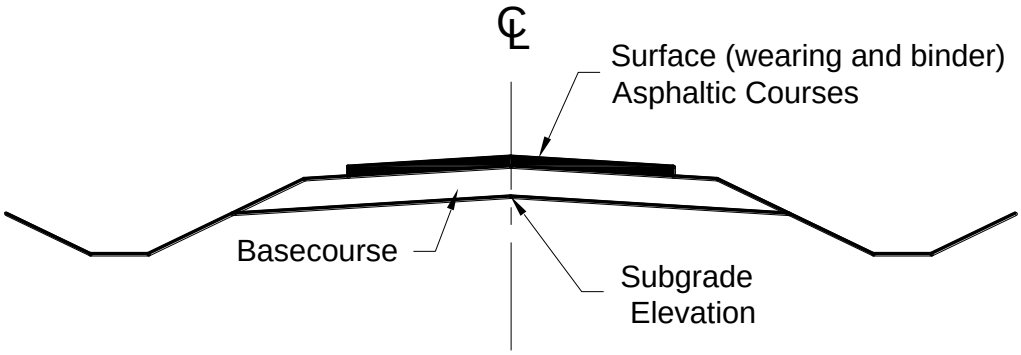
d. Consider station 110 + 83, what is the approximate fore-slope length (*level length*) at this station? (*Hint: Look on Sheet 401*) _____

FINISHED SECTIONS

6-20. When the preparation of the subgrade is complete, construction of the highway begins. Below is an illustration of a **completed subgrade**.



6-21. The **base and surface courses** go on top of the subgrade. See the illustration below.



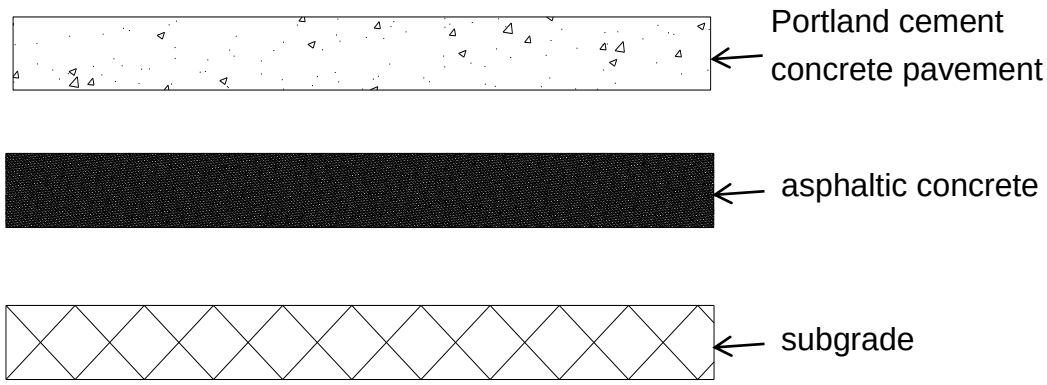
The example above is for an asphaltic concrete surface, a Portland cement concrete surface is similar.

Fill in the blanks with the correct answer.

a. Two courses (layers) are applied over the prepared subgrade; they are the _____ course and the_____ course.

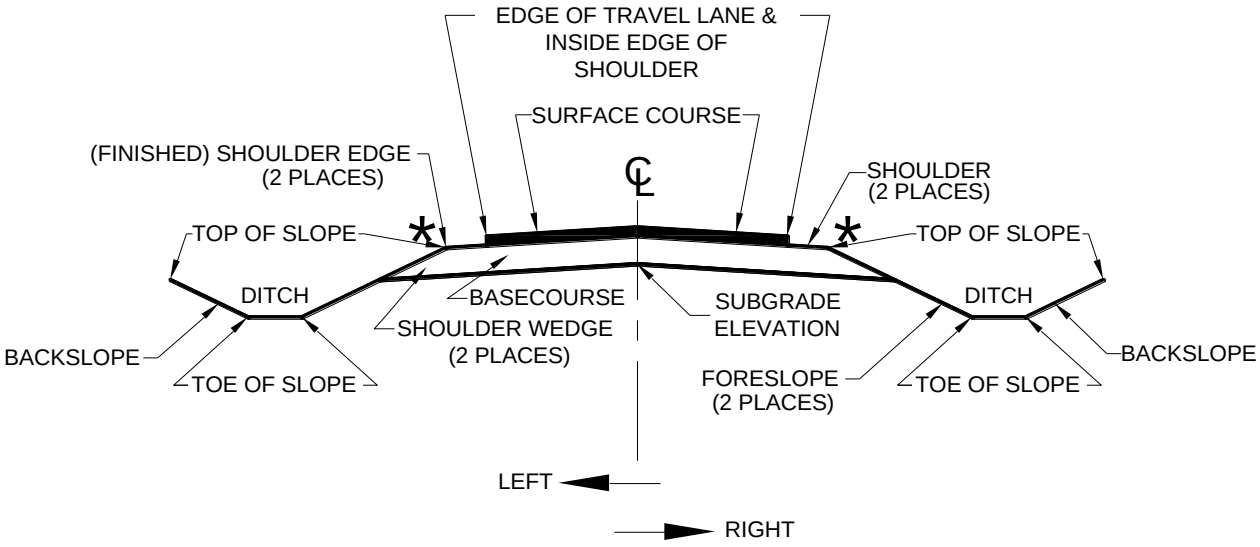
6-22. Refer to the **Typical FINISHED Section** on sheet 2 *(I-12, Dumplin Creek)* in the Highway Plan Book. The legend on the right of the section identifies each layer. Each roadway lane is made up of a 12″ Portland cement surface with a 2″ asphaltic concrete base course, these sit atop a 6″ subgrade layer.

Shown below are symbols representing the materials found in the Typical Finished Section. The latest version of the Standard Specifications book contains additional information about these materials.



6-23. Here is a **TYPICAL FINISHED SECTION** drawing complete with nomenclature. Observe that it is similar to the Typical Grading Section, but has additional details and terms.

✱Note that the top of the fore-slope on the Typical Finished Section is in a different location, adding the Base-Course raised the elevation of the "inside" edge.



6-24. Refer to the **Typical FINISHED Section** on sheet 2 *(I-12, Dumplin Creek)* in the Highway Plan Book; fill in the blanks with the correct answer.

a. Record the total distance between the inside edges (top) of the left and right fore-slopes. _____

b. Record the slope of the RIGHT concrete shoulder. _____

c. What is the total width of the asphaltic concrete base course? _____

d. What is the thickness of the asphaltic concrete base course? _____

e. How far to the left of the centerline is the note "Grade Shown on Profile?"

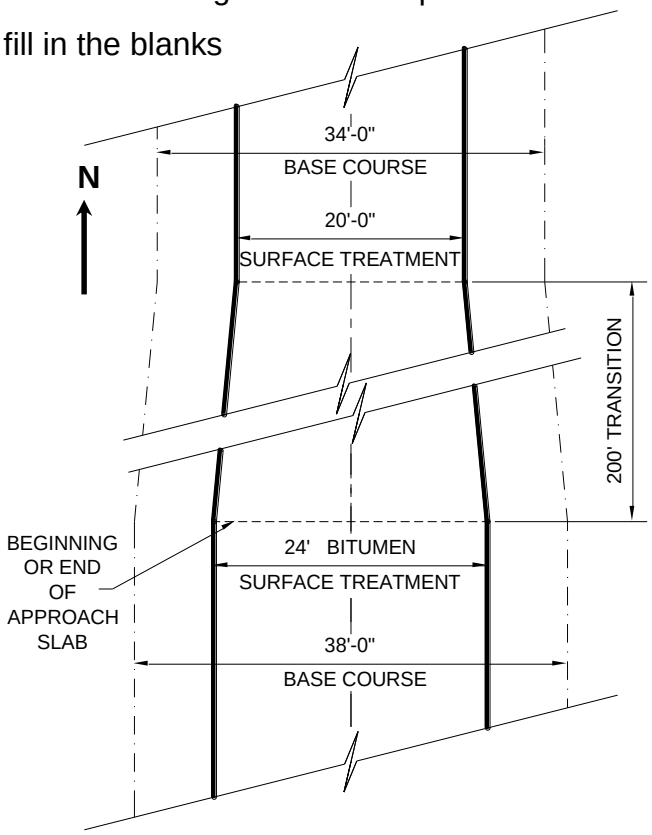
_____

f. What is the distance between the inside edge of the shoulder *(at travel lane)* and the top of the fore-slope? _____

g. What is the horizontal distance between the outside edge of the shoulder and the outside edge of the subgrade layer? _____

TRANSITIONS

6-25. There are many places where **transitions** are necessary in road and bridge construction projects. For example, as a roadway advances toward a bridge, the base course and wearing surface course **become wider** to join the approach slab. This change in width is called "**transition**." To the right is an example showing a transition. Refer to it and fill in the blanks with the correct answer.



a. The normal width of the base course is _____.

b. Record the width of the base course where it joins the approach slab.

_____

c. Determine the width of the bituminous surface at 100′ or ½ of the transition.

_____

d. _____ is the term used when a roadway widens to join a bridge.

e. Traveling North to South, how wide is the approach slab at full transition?

_____

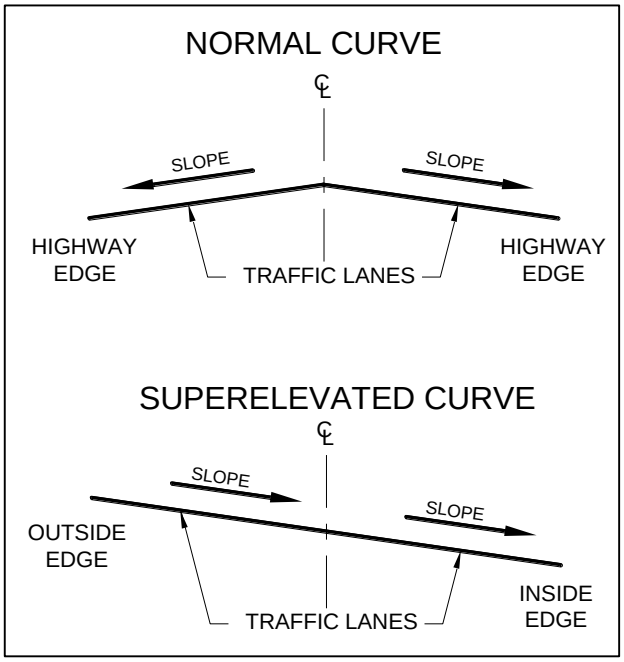
f. Record the transition length. _____

SUPERELEVATION

6-26. Until now, the topics in this chapter discussed typical sections with straight or tangent roadway segments and conventional slopes.

Roadway curves require **SUPERELEVATION**. Super elevating a curve helps cars stay on the highway as they proceed, particularly at higher speeds.

Refer to the illustrations on the right.



A curve has a **NORMAL CROWN** when it is NOT superelevated; its slope is the same as any other tangent segment of the highway. Notice that the traffic lanes on the illustration slope down uniformly from the centerline.

When a curve **SUPERELEVATES**, the outside edge of the highway is higher than the inside edge, and **the entire roadway slopes down to the inside of the curve**

Fill in the blanks with the correct answer.

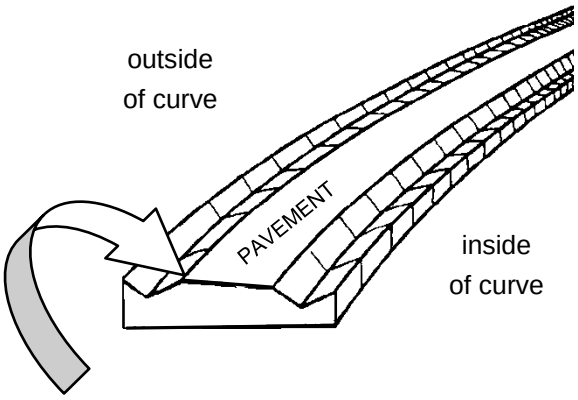
a. A curve is _____ when the pavement slopes down toward the inside of the curve.

b. Normal curves slope from the _____ to the _____.

c. Superelevated curves slope from the _____ to the _____ edge of the highway.

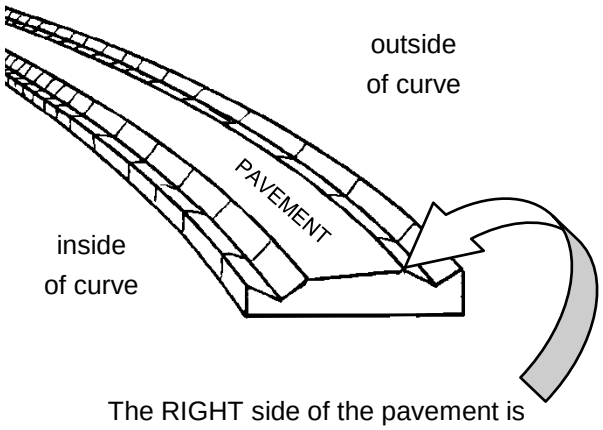
6-27. Study the illustration below, it shows two cross sections of a roadway, one curving to the left, the other curving to the right. This information illustrates the basic concepts associated with **SUPERELEVATION**.

RIGHT TURN



The LEFT side of the pavement is higher when the curve is turning to the RIGHT. The pavement slopes down to the INSIDE of the curve.

LEFT TURN



The RIGHT side of the pavement is higher when the curve is turning to the LEFT. The pavement slopes down to the INSIDE of the curve.

Use the Superelevation illustration above to answer the following questions, write the word "**inside**" or "**outside**" to fill in the blanks provided.

a. Which edge of the curve is built up higher than normal? _____

b. Consider a LEFT hand curve, the pavement slopes down to the _____.

c. Consider a RIGHT hand curve, the pavement slopes down to the _____.

Use the Superelevation illustration above to answer the following questions, write the word "**left**" or "**right**" to fill in the blanks provided.

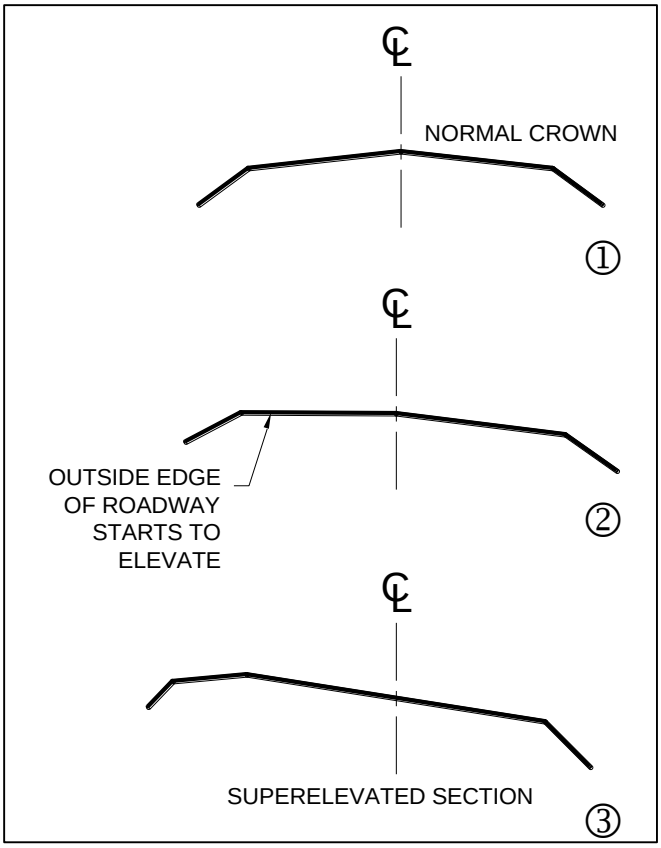
d. For LEFT turning curves, the inside of the curve is on the _____.

e. For RIGHT turning curves, the inside of the curve is on the_____.

f. Right turning curves are built up higher on the _____ side.

g. Left turning curves are built up higher on the _____ side.

6-28. Superelevation requires elevating one side of the highway higher than it is ordinarily in a “Normal Curve.”



Look at the Cross Section drawing to the right; it illustrates the three steps necessary to achieve superelevation of a roadway curving to the right.

Starting as a **Normal Crown**, the cross-section shows both sides of the pavement sloping down from the centerline.

At the start of superelevation, the left edge of the highway elevates until it reaches **full superelevation**, remaining at **full superelevation** through the curve – then it returns to a Normal Crown on a tangent segment of the highway.

FULL superelevation does not start suddenly – it builds up gradually, and gradually goes down.

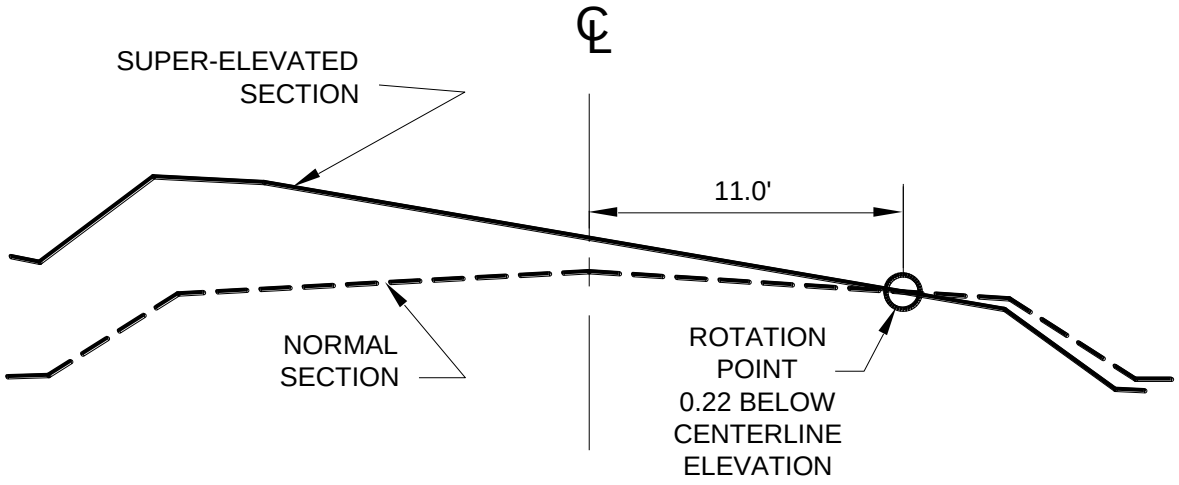
6-29. Refer to the illustration below.

- dashed lines represent a normal highway section ***before*** superelevation
- a solid line represents the highway section ***full*** superelevation.

Observe the **rotation point**; it remains fixed as the highway superelevates.

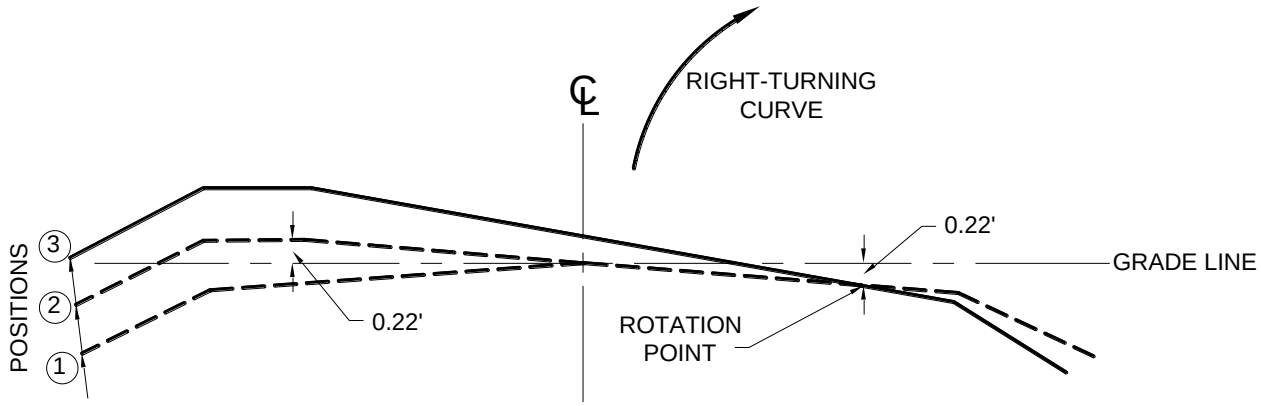
Notice that to the right of the rotation point, the shoulder and fore-slope drop in elevation as the superelevation increases.

Likewise, to the left of the rotation point, the pavement, shoulder, and fore-slope all rise as superelevation increases.



6-30. Refer to the drawing below, it illustrates a right-turning curve going from a Normal Crown **transitioning** to a Superelevation.

Starting as a Normal Crown, the curve begins to change; notice the outside starting to rotate up. When the pavement reaches a "**straight slope,**" (sloping down from the outside edge to the inside edge – position 2,) it is referred to as the "**point where superelevation is equal to tangent crown**."



Refer to the drawing above.

- Position ① represents the highway **before the transition** into superelevation.
- Position ② represents the point where superelevation is **equal to tangent crown**.
- Position ③ represents **full superelevation**.

Notice that the entire roadway rotated between positions ② and position ③and the right shoulder dropped. One point did not change position during the entire transition, the right rotation point. It remained at a constant distance, 0.22′ below the grade line. If this were a left turning curve, the left rotation point would also remain constant.

6-31. Prior to moving to the next topic, read the following statements concerning the superelevation process. Then, refer to the illustrations from topics 6-28, 6-29, and 6-30. Place checkmarks in the boxes after reviewing each point.

- ☐ The left edge of the roadway elevates and becomes the outside edge of the curve.
- ☐ At position ② the slope of the outside shoulder has decreased.
- ☐ At position ② the crown is tangent, the pavement is a straight line from edge to edge.
- ☐ At position ②, the entire roadway begins to rotate.
- ☐ The illustration shows a road curving to the right.
- ☐ The right edge of the roadway becomes the inside edge of the curve.
- ☐ The inside shoulder will lose elevation between positions ② and ③.

Refer to the drawing in topic 6-30; fill in the blanks with the correct answer.

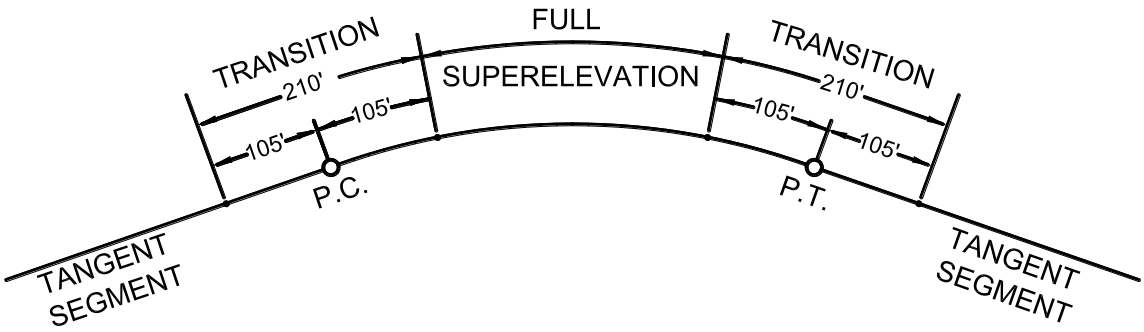
a. The entire roadway begins to rotate at position _____.

b. What is the horizontal distance from the centerline to the rotation point? _____

c. Record the distance between the centerline elevation and the rotation point. _____

6-32. Remember, **FULL superelevation** does not start suddenly; it builds up gradually, and gradually goes down.

Examine the drawing below; it illustrates a straight roadway moving through a right turning curve, returning to a straight section of roadway. The **straight roadways are tangent segments** of road leading in and out of the curve.



Between Normal Crown and FULL superelevation is the **TRANSITION;** this is where the superelevation gradually builds up on both sides of the curve's **point of curvature (PC)** until reaching FULL superelevation. FULL superelevation continues through the curve, and then begins to come down transitioning through the curve's **point of tangency (PT**.)

Above is an example of a curve with a 210′ **TRANSITION** distance. Observe that the **Transition to Superelevation** begins 105′ before **P.C**. (beginning of the curve,) reaching full superelevation 105′ after **P.C.**

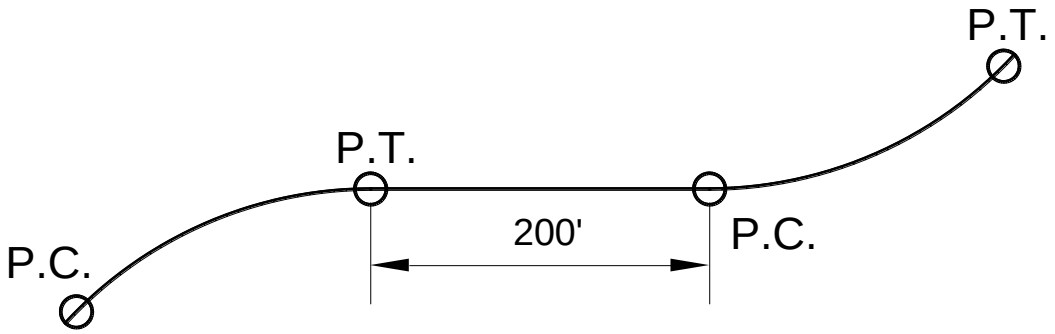
Full superelevation starts to come down 105′ feet before **P.T.** (the curve end,) and ends 105′ after **P.T.**

Refer to the drawing above, fill in the blank with the correct answer.

a. How much of the curve is **NOT** at FULL superelevation? _____ (use total feet)

6-33. Illustrated below are two curves with a tangent segment between them. 200 feet separate the P.T. of the first curve and the P.C. of the second curve. Prior to superelevation, each curve needs a minimum transition distance. For instance, if the calculated transition distance for each curve were 250 feet, each curve would need 125 feet of transition distance before and after P.C. and P.T. In this case, there is not enough distance available.

Making the transition distance shorter or "pushing" the transition distance back into the curve is **unacceptable**, redesigning the roadway is the solution. Avoiding such a situation is best.



`

Fill in the blank with the correct answer.

a. If a plan set indicates that the tangent distance between two curves is too short to accommodate the transition length between curves, the solution to the situation is _____.

6-34. Turn to **Sheet 2h** *(I-12, Dumplin Creek)* in the Highway Plan Book, it displays the general information for the superelevation of a curve on the U.S. 190 portion of the this project.

Examine sheet 2h, three areas contain relevant superelevation information:

- The table of **SUPERELEVATION VALUES FOR RURAL OVERLAYS** (upper left corner)
- A **SUPERELEVATED SECTION drawing** (upper right corner)
- A **SUPERELEVATION DIAGRAM** - for Left Curvature (under the section drawing.)

6-34. *(continued)*

Examine the **SUPERELEVATION DIAGRAM** on sheet 2h; it defines the elevation variances of the overlay material for the left and right edges throughout the length of the superelevated section of the highway.

Locate points A and B on the left side of the **diagram**, they represent the left, and right edges of the roadway; observe that they are at the same elevation. As the superelevation proceeds through the **runoff** *(transition,)* the elevation of the left edge *(A)* remains constant while the right edge elevation *(B)* increases, reaching its maximum elevation at full superelevation.

Along the top of the **Superelevation Diagram** are notes given in terms of percentages, these indicate allowable variances of runoff length before and after the P.C. and P.T.

The **SUPERELEVATED SECTION** is a cross section containing detailed information about each roadway component. It also defines the location of the points A and B *(from the Superelevation Diagram.)* Also, notice that written on top of the roadway "width" is an "**R**," indicating the **rate of superelevation** *(Ft. per Ft.)*

On the left side of sheet 2h, contained within the table of **SUPERELEVATION VALUES FOR RURAL OVERLAYS** is information relevant to various roadway conditions, e.g. *MPH, Degree of Curve, Length of Superelevation, Runoff, etc*. Listed below are a few tips to help access the information within the table.

- Across the top of table is the **MPH** (**design speed)** row.
- Down the left side of table is a column showing **degree of curve (D)**
- Under the MPH-design speeds is a row showing

  R - rate of superelevation and

  L - length of superelevation runoff for each degree of curve.
- The body of the table contains **the desirable (Des.)** and **minimum (Min.)** values for each **R** and **L**

6-34. *(continued)*

Practice looking for information within the *Superelevation Values for Rural Overlays* table.

Find the 40 MPH design speed, and the **10°00′ degree of curvature** (**D.**) Locate the intersection of the two values; notice that the desirable (Des.) values for R and L are .093 foot per foot and 200′ respectively.

Now, use the table of **SUPERELEVATION VALUES FOR RURAL OVERLAYS to fill in the blanks with the correct answer.**

a. Record the desirable length of superelevation runoff (**L**) for a curve with a design speed of **50 MPH** and a degree of curve **(D) of 8° 00′**. _____

b. What is the desirable rate of superelevation (**R**) for the same curve? _____

***** It is possible to determine the difference in elevation between the left and right edges of the roadway at full superelevation using the **R** and **L** values.

For example, given the following information:

- if the lane width is 12 feet *(a 24′ roadway width)*
- the desirable “R” value is .093
- the desirable “L” value is 200′
- 50% of the runoff is before the PC

Roadway Width X **R** *(rate of superelevation)* = elevation difference at full superelevation

24′ x .093 (**R**) = **2.232′** is the difference in elevation between the left and right edges at full superelevation

50% of 200′ (**L**) = **100′** is the runoff (*transition)* length from the tangent section (P.C.)

½ of 2.232′ = **1.116′** is the difference in elevation between the left and right edges at a runoff (*transition)* length of 100′ from the tangent section (P.C.)

6-34. *(continued)*

Use the R and L values from questions “a & b” on the previous page to calculate the difference in elevation between the left and right edges at full superelevation, and at ½ the runoff from P.C. The roadway width is 24′.

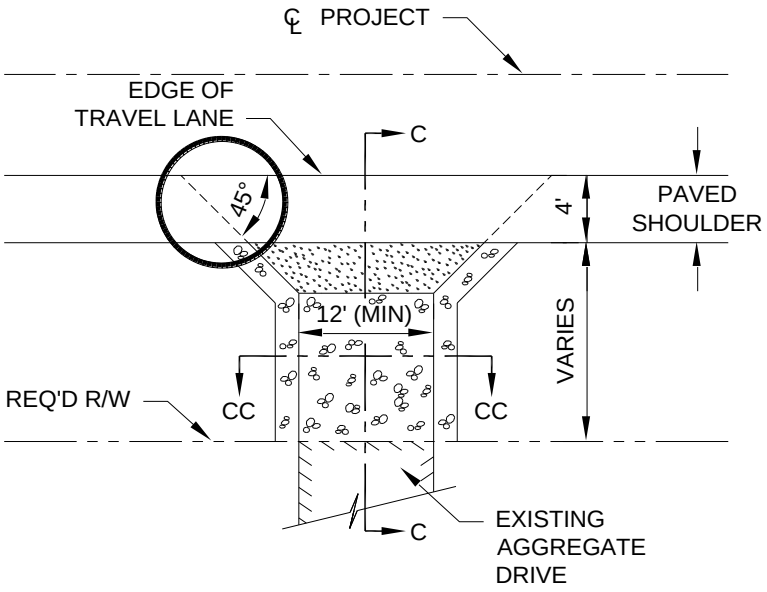
c. elevation difference at full superelevation = _____

d. elevation difference at ½ the runoff from P.C. = _____

DRIVEWAYS

6-35. To allow property owners necessary access to the highway, the department designs driveways at various points along a project. Shown below is a “**driveway**” drawing similar to one on the department’s Standard Plan set DW-03. This example is a rural highway with a **paved shoulder** connecting to an existing **aggregate drive** leading to a residence or commercial establishment.

Circled in the illustration below is a triangular “**driveway flare**.” Notice both sides of the driveway have 45° flares permitting vehicles easier access when turning on and off the highway.



TYPE "C"
PAVED DRIVE ALONG
PAVED SHOULDER

CHAPTER 6 REVIEW QUESTIONS

6-36. Refer to the **TYPICAL GRADING SECTION** at the top of Typical Sections and Details Sheet **2** *(I-12, Dumplin Creek)* in the Highway Plan Book. Fill in the blanks with the correct answer.

a. Seeding and fertilizing is prepared between the top of the _____ and the _____.

b. The width of the ditch bottom on the cut section is _____.

c. The width of the fore-slope on the cut section is a minimum of _____.

d. The minimum difference in elevation between the top of the fore-slope and the ditch bottom is _____.

e. Calculate the difference in elevation between the top of the backslope and the ditch bottom if the horizontal length of the backslope is 12 feet.

_____

Refer to the **TYPICAL FINISHED SECTION** on Typical Sections and Details Sheet **2** *(I-12, Dumplin Creek)* in the Highway Plan Book to answer the following questions. Fill in the blanks with the correct answer.

f. What is the distance between the left and right outside finished shoulder edges? _____

g. What is the width of the base course? _____

h. What is the thickness of the Portland cement concrete pavement for the travel lanes? _____

i. Is the location of the “grade shown on profile” located at the true centerline of the roadway? _____

j. Is the thickness of the subgrade layer specified? _____

k. What is the difference in elevation between the edge of travel lane and top of fore-slope? _____

CHAPTER 6 REVIEW QUESTIONS *(continued)*

6-36. *(continued)*

Refer to **TYPICAL SECTIONS AND DETAILS** Sheet **2h** *(I-12, Dumplin Creek)* in the Highway Plan Book to answer the following questions.

Use a 6° 00′ degree of curve with a 50 MPH design speed and 12 foot lane widths. Answer the following questions; fill in the blanks with the correct answer.

l. What is the desirable rate of superelevation (R)? _____

m. What is desirable transition length (L)? _____

n. What is the difference in elevation between the inside shoulder edges at full superelevation? _____

o. If 50% of the runoff is before the PC and after the PT, how many feet of the curve are **NOT** at FULL superelevation? _____

p. What is the rate of superelevation at the PC, if 50% of the runoff is before the PC? _____

***Note**: Check your responses against answer sheets found at the end of this manual. If you missed MORE than three questions, review this chapter again and correct any wrong answers before progressing.*

TRAINING NOTES

TRAINING NOTES

APPENDIX A

Definitions

Approach slab	A slab of concrete connecting a roadway to a bridge.
Average Daily Traffic (ADT)	The total traffic volume during a given time period divided by the number of days in the period.
Base Course	The layer or layers of specified material of design thickness, constructed on the subgrade to support a surface course.
Base Line	The North-South Dividing line used as a reference for township line numbers. There is one *base line* used in Louisiana
Bearing Number	Indicates the direction of a line. (e.g. a centerline, side of a parcel, etc.)
Bench Mark	A permanent point (monument) of known elevation
Bent	The *bent* is the supporting structure for the bridge. The two major parts of the *bent* are the piles and the cap.
Berm	An embankment constructed at both ends of the bridge to provide stabilization of the bridge ends.
Bulkhead	A retaining wall holding back the fill on either side of the approach slab.
Cap	The horizontal support member of the bent. The rest of the bridge structure is built over the *cap*.
Control of Access	The condition where the right of owners or occupants of abutting land or other persons, to access, light, air, or view, in connection with a highway that is controlled by public authority.
Cross-Section View	A view showing the inside of an object as though a piece of the object has been sliced away.
Culvert	Any drainage structure under a roadway or other facility not defined as a bridge.
Delta (Δ)	Indicates the amount of bearing change to the right or left between the two tangent segments of the highway before and after a curve.
Design Drainage Maps	Used to show basic drainage design data including hydrologic information and the design criteria for cross-drain structures. With regard to urban projects, it shows the basic design data for a storm sewer system.

Design Hourly Volume (DHV)	The peak hourly volume of traffic expected in the 30th highest hour during the chosen design year.
Directional Distribution (D)	A measure of the highest traffic volume in one direction during peak hours, expressed as a percentage of DHV
Elevation	The vertical distance of a point above or below a reference surface.
Elevation View	A view showing the height of an object. *Elevations* may be from the front, rear or side views.
Equation	A distance used to relate the difference in length of a section when the station number of a given point is changed for various reasons.
Existing Drainage Maps	A map indicating the size, shape, and direction of flow for all drainage structures affecting drainage with regard to the proposed roadway. It includes the size of all existing drainage structures under all existing roadways and railroads in the vicinity.
Grade	The slope of a land segment.
Invitation to Bid	An advertisement for bids for all work or materials on which bids are required. The advertisement *(invitation to bid)* indicates the location and description of the work as well as the time and place of bid openings.
Length (L)	The length of a curve from the P.C. to the P.T.
Notice to Proceed	Written notice to the contractor to proceed with the contract work, including the date of beginning of contract time.
Parcels	A land area needed for construction, or other purposes.
Piles	The vertical support members of the bent driven into the ground to support the bridge structure.
Plan Change	A general term denoting changes to the contract and implemented by a Plan Change and/or Special Agreement.
Plan Change and/or Special Agreement	A document describing and detailing changes to the contract. It establishes reasons for the changes, specification requirements, method of measurement, basis of payment, etc.

Plans	Contract drawings, showing location, type, dimensions, and other details of the prescribed work.
Plan View	A view from directly above the object, looking down on the object.
Point of Curvature (P.C.)	The point where the tangent (or straight) segment of the highway begins to curve.
Point of Intersection (P.I.)	The point where the extension lines of the tangent segments meet or intersect.
Point of Tangency (P.T.)	The point where the curved segment of the highway ends, and a new tangent segment begins.
Principal Meridian	• The East-West Dividing line used as a reference for range lines. • Louisiana has two Principal Meridians • The Louisiana Principal Meridian is used for that part of the state **west** of the Mississippi River, and the St. Helena Principal Meridian is used for the part of the state **east** of the Mississippi River.
Project Number	A number used to identify a project.
Proposal	The offer of a bidder, on the prescribed form, to perform the stated work and to furnish materials and labor at the prices quoted
Radius (R)	The radius of a curve.
Roadway	The portion of a highway that is improved, designed, or ordinarily used for vehicular travel, exclusive of the shoulder.
Range Lines	Lines drawn parallel to the West-East Dividing line at six-mile intervals.
Right-of-Way	1) As a result of transportation improvement projects, it is at times necessary for the state to acquire private property to expand or improve the existing transportation system. 2) Land, property or interest therein, acquired for or devoted to transportation purposes. 3) Signifies that the Department has the right to pass over the property of others within the limits of construction. 4) Right-of-way is also a project phase.

Section	A division of a township. Most townships are divided into 36 one-mile square sections.
Span	The roadway over the bridge. A span reaches from one side of the bridge to the other and one bent to the next bent.
Special Provisions	Additions and revisions to the standard and supplemental specifications covering conditions applicable to the project.
Specifications	The compilation of provisions and requirements for the performance of prescribed work.
Standard Specifications	A book of specifications for general application and repetitive use.
Station numbers	Used to measure distance along the length of a project. One station represents a distance of 100 feet.
Subgrade	The top surface of a roadbed upon which the pavement structure, shoulders, and curbs are constructed.
Superelevation	A change in the cross slope of a roadway to help cars stay on the highway as they go around curves at high speeds. A curve is *superelevated* when the whole pavement slopes down toward the inside of the curve.
Supplemental Specifications	Additions and revisions to the Standard Specifications.
Surface Course	The top course of the pavement structure.
T	The tangent distance from the P.C. to the P.I., or the P.I. to the P.T. Both distances are the same.
Temporary Bench Mark	A point of known elevation established for temporary use during construction of a project.
Township	An area of land normally 36 square miles
Township Lines	Lines drawn parallel to the North-South Dividing line at six-mile intervals.
Vertical Curve	A parabolic curve connecting the tangent segments of a highway in the “up and down” or vertical direction.

APPENDIX B

Chapter Answers

CHAPTER ONE ANSWERS

1-1. **a**. Written agreement
b. Invitation to Bid
c. Plans
d. Standard Specifications, Supplemental Specifications, Special Provisions
e. Proposal
f. Notice to Proceed
g. Plan Change
h. Plans
i. Change Order
j. Change Order

1-2. **a**. Special Provisions
b. Standard Specifications
c. Special Provisions
d. Supplemental Specifications

1-3. **1**. Special Provisions
2. Plans
3. Supplemental Specifications
4. Standard Specifications

1-4. **a**. Interpret
b. What and Where
c. Related
d. Clean and in order

CHAPTER TWO ANSWERS

2-1. No answer required

2-2. **a**. Federal
b. State

2-3. No answer required

2-4.

a. Federal Project No.	**d**. Identifying	**g**. No	**j**. D. Krone	**m**. Drain Canal Bridges on U.S. 90
b. State Project No.	**e**. Title	**h**. H. 000238	**k**. Jefferson	
c. Project Name	**f**. One (1)	**i**. A. Davis	**l**. 04/15/2011	

2-5.

a. Drain Canal Bridges on U.S. 90	**c**. S.P. NO. H. 000238	**e**. U.S. 90
b. F.A.P. No. 5702(011)	**d**. Jefferson Parish	

2-6.

a. Title Block	**c**. Captions around Layout Map	**e**. Federal Project Number
b. Project Caption	**d**. State Project Number	**f**. Project name

2-7. No answer required

2-8. No answer required

2-9.

a. Surface Transportation Program	**b**. Bridge Replacement	**c**. Transportation Equity Act of the 21st Century

2-10. No answer required

2-11.

Control No.	Section No.	No. of Projects
064	06	0036
407	03	0018
829	10	0013
213	08	0007

CHAPTER TWO ANSWERS (continued)

2-12. **a**. emergency event for FEMA **b**. an emergency event for FHWA **c**. False

2-13.

a. Construction	**c**. an emergency event for FHWA
b. Single Activity	**d**. an emergency event for FEMA

2-14. No answer required

2-15. No answer required

2-16. No answer required

2-17. No answer required

2-18.

a. Plan	**c**. Side Elevation
b. Front Elevation	**d**. Cross section

2-19. No answer required

2-20. No answer required

2-21.

a. Left	**c**. 24″
b. 6-1/2″ Min.	**d**. 2″

2-22. No answer required

2-23. No answer required

2-24. **a**. Title Block **b**. Vicinity Map **c**. Project Caption

2-25. No answer required

2-26. No answer required

2-27.

a. U.S. 190	**c**. 447, 1024, 1026, 1027, 1029, 449
b. I - 12	**d**. 447, U.S. 190, LA 1027

2-28. No answer required

CHAPTER TWO ANSWERS (continued)

2-29. **a**. Begin Site NO. 1 H. 000238 = **STA. 101 + 62.11**
b. End Site NO. 1 H. 000238 = **STA. 119 + 97.89**
c. C.S. Log mile = **2.70**
d. F.A.P. number Begin Site NO. 1 = **F.A.P. NO. 5702(011)**

2-30. **a**. 1″ = 2,000 feet **b**. scale

2-31. Greensburg Land District, T7S-R3E, T6S-R3E, Sections 1 and 36

2-32. No answer required
2-33. No answer required
2-34. No answer required
2-35. No answer required
2-36. No answer required
2-37. No answer required
2-38. No answer required

2-39.
a. 36
b. 144
c. 4
d. 16
e. 576
f. One (1)
g. ½ mile
h. 6 miles
i. ¼ mile
j. 160 acres
k. 640 acres
l. 23,040 acres
m. 40 acres
n. T1S-R4W
o. T40N-R11W

p.

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

q. 2
r. 1
s. true
t. true

CHAPTER TWO ANSWERS (continued)

2-40. 200 feet

2-41. No answer required

2-42. **a**. STA. 8 + 43.00 **b**. STA. 244 + 44.00 **c**. STA. 11 + 60.00

2-43. No answer required

2-44. 886'

2-45. No answer required

2-46.

a. 2,563 feet	**c**. 58,436 feet
b. 14 feet	**d**. 39,302 feet

2-47. **a**. 3,158.50 feet **b**. 448.40 feet

2-48. No answer required

2-49. No answer required

2-50.

a. EQ. = + 39.44′	**c**. EQ. = - 2.80′	**e**. L.B. = STA. 94 + 60.84	**g**. L.A. = STA. 52 + 65.97
b. EQ. = - 93′	**d**. L.A. = STA. 40 + 80.00	**f.** EQ. = + 20.00	**h**. L.B. = STA. 25 + 37.09

2-51. No answer needed

2-52. No answer needed

2-53. **a**. none noted **b**. 1835.78 ft. **c**. 4854.16 ft. **d**. 0.015 miles **e**. 0.602 miles

2-54. **Calculate the length of this bridge by subtracting**
STA. 110 + 08 from STA. 110 + 85

11085 – 11008 = **77′** (*although the title sheet reads - 77.50*′)

2-55. **a**. STA. 45 + 00, O/S 51′ RT of ℄ or STA. 45 + 00, 51′ right of the centerline

b. STA. 46 + 68, 56′ Right of centerline

CHAPTER TWO ANSWERS (continued)

2-56.

a. 	**c**. Right	**e**. STA. 8 + 00, 40′ Right of Centerline
b. 	**d**. Left	

2-57.

a. 0.632	**c**. STA. 202 + 91.91 & STA. 217 + 90.51	**e**. West to East	**g**. Jefferson
b. STA. 101 + 62.11 & STA. 119 + 97.89	**d**. West to East	**f**. 0.030 miles	

2-58. No answer needed

2-59. **a**. level books 186-951 **b**. elevation **c**. benchmark **d**. vertical

2-60. **a**. Transit **b**. Level

2-61.

a. lower left corner above the Schedule of Revisions	**c**. 10%, projected A.D.T.
b. 11%, T	**d**. 55%

2-62. *Drain Canal* **a**. yes **b**. yes **c**. Sheet 1 (Title Sheet), lower left corner

2-63. *Dumplin Creek* **a**. yes **b**. yes **c**. twice **d**. 1, 15, 19, 102, 1, 3a, 3f, 3g **e**. no

2-64.

a. 4 & 5	**d**. 3 - 3a	**g**. 401- 405	**j**. none noted
b. none noted	**e**. Title sheet	**h**. 77	**k**. 2
c. Index to sheets	**f**. 101-115	**i**. Sheet 1a	

2-65.

a. 4 - 26, & 27 - 39	**d**. 3 - 3i	**g**. 46 - 55	**j**. 301-340
b. 401 - 443	**e**. 201 - 228	**h**. upper left corner of Title Sheet	**k**. 104 - 129
c. insufficient room on sheet 1	**f**. Index to Sheets	**i**. 95 - 103	

CHAPTER TWO FINAL REVIEW QUESTIONS

a. United States	**f**. there are no P & P sheets	**k**. Jefferson	**p**. 1″ = 2,000 ft.
b. H.000238	**g**. 77.50 ft.	**l**. 5	**q**. 1
c. 155 ft.	**h**. 119 + 97.89	**m**. 45 mph	**r**. STA. 217 + 90.51
d. west to east	**i**. 46,900	**n**. yes	**s**. STA. 101 + 62.11
e. .632 miles	**j**. 2	**o**. up	**t**. Waggaman

CHAPTER 3 – ANSWERS

3-1.

a. Index to Sheets	**c**. aerial-photograph, Drawn	**e**. Identification Box & North Arrow
b. 95 – 103	**d**. Property (parcels)	

3-2. No answer required

3-3.

a. Title Block (Box)	**c**. 1″ = 50′	**e**. 1/7/94	**g**. FILE NO. 2-13-1-86
b. I – 12 – Dumplin Creek	**d**. 1″ = 100′	**f**. 1 (one)	

3-4. **a**. Right **b**. West

3-5.

a. Pendarvis Lane	**b**. T7S – R3E and T6S – R3E	**c**. sections 1 & 36

3-6. **a**. McDonald's Corp. **b**. John E. Coxe, Sr., ET UX

3-7. **a**. Right – of – way

3-8. No answer required

3-9. **a**. R/W or ROW **b**. Check mark next to the lowest line

3-10. Yes

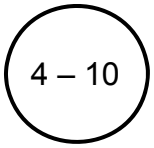
3-11. No answer required

3-12.

a. 0.046 acre	**b**. 0.786 acre	**c**. 0.832 acre

3-13. **a**. C

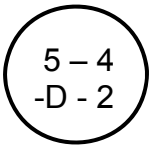
3-14.



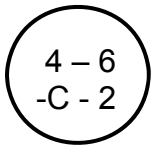
3-15. No answer required

CHAPTER 3 – ANSWERS *(continued)*

3-16.



3-17. **a**.



3-18. No answer required

3-19.

a. 8 – 3 – 2	**b**. A - (11-4-1)	**c**. Construction	**d.** Drainage

3-20. No answer required

3-21.

a. Right-of-Way	**d**. Drainage	**g**. R/W sheet 8, 1st, Construction servitude	**j**. Right-of-Way, used for Project construction
b. Right-of-Way, used for Project construction	**e**. R/W sheet 2, 1st, Drainage servitude	**h**. Right-of-Way, used for Project construction	**k**. R/W sheet 2, 2nd, "Revised" Right-of-Way
c. 3rd parcel on R/W sheet 2	**f**. Construction detour	**i**. R/W sheet 3, 1st, Additional Acquisition Right-of-Way	

3-22. No answer required

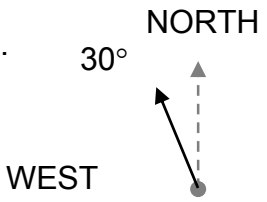
3-23. No answer required

3-24.

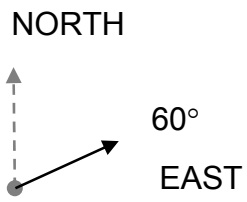
a. OB SE (lower-right) COUNTER CLOCK-WISE E (east), 37° S 37° 00′ 00″ E	**b**. OC SW (lower-left) CLOCK-WISE W (west), 50° S 50° 00′ 00″ W

CHAPTER 3 – ANSWERS *(continued)*

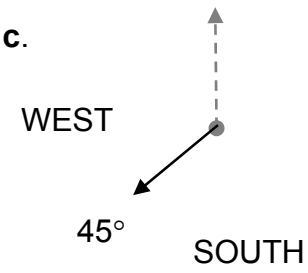
3-25. **a**.



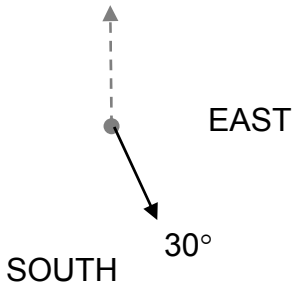
b.



c.



d.



3-26.

a. 15.25′	**c**. 12.19′	**e**. 145. 09′	**g**. 145.00′
b. S 89° 09′ 50″ W	**d**. S 89° 09′ 50″ W	**f**. N 03° 03′ 58″ W	**h**. S 1° 51′ 32″ E

3-27. **a**. 85′ **b.** 155′

3-28. No answer required

3-29. No answer required

3-30.

a. tangent	**b**. right	**c**. left

3-31. No answer required

3-32.

a. PC - Point of Curvature	**c**. PI- Point of Intersection	**e**. STA. 29 + 75
b. PT- Point of Tangency	**d**. STA. 25+40	

3-33. No Answer Required

3-34. No Answer Required

CHAPTER 3 – ANSWERS *(continued)*

3-35. **a**. 44 + 50 **b**. N 60° 01′ 04″ E

3-36. **a**. PI = Tangent length + STA. of PC
PI = 505′ + 5300
PI = STA. 58+05

b. PT = L+ STA of PC
PT = 693′ + 5300
PT = STA. 59 + 93

3-37. No Answer Required

3-38.

a. Delta = Bearing Change	**c**. L = Length of curve	**e**. PT = Point of Tangency	**g**. PC = Point of Curvature
b. PI = Point of Intersection	**d**. T = Tangent distance to PI	**f**. R = Radius	

3-39.

a. Tangent distance to PI = T	**d**. T = Tangent distance	**g**. L = Length of Curvature	**j**. Δ = Bearing Change
b. PI = Point of Intersection	**e**. Δ = Bearing Change	**h**. Radius	
c. PC = Point of Curvature	**f**. PT = Point of Tangency	**i**. Radius	

3-40. **a**. PCC = Point of Compound Curvature

b. PRC = Point of Reverse Curvature

3-41.

a. STA. 213 + 47.30	**d**. Δ = 7° 35′ RT	**g**. L = 702.78′
b. STA. 208 + 89.94	**e**. T = 457.36′	
c. 6830.69′	**f**. T = 457.36′	

CHAPTER 3 – ANSWERS *(continued)*

3-42.

	Letters associated with a given parcel symbol	Location (R/W Sheet number)	R/W Parcel number	Type Of Parcel	Purpose or distinction	Has this parcel previously encountered changes? (Y/N)
a.	4-3-D-1	4	4-3	Drainage Servitude	Drainage	NO
b.	4-2-R-1	4	4-2	R/W Revised	Project Construction	NO
c.	8-5-C-2	8	8-5	Construction Servitude	Construction Detour	NO
d.	6-4-A-2	6	6-4	R/W Additional Acquisition	Project Construction	YES
e.	4-4	4	4-4	R/W	Project Construction	NO
f.	11-4-1	11	11-4	R/W	Controlled Access	n/a

3-43.

a. P.T.	**d**. P.I.	**g**. R
b. P.C.	**e**. L	**h**. T
c. P.C.C.	**f**. P.R.C.	**i**. Δ

3-44.

a. John E. Coxe, SR., ET UX	**d**. iron pipes
b. 0.200 acre	**e**. STA. 119 + 76.95
c. N 29.81′ S 26.20′ E 107.47′+ 217.52′ = 324.99′ W 104.43′+ 220.64′ = 325.07′	**f**. STA. 116 + 52.38
	g. and wife

3-45.

a. Property Line	**b**. R/W line	**c**. Limits of Construction

CHAPTER 3 – ANSWERS *(continued)*

3-46.

a. P.T. = STA. 149 + 16.87	**g**. P.I. = 14748.73 P.C. = 14578.10 Distance (difference) between P.C. and P.I. = 170.63′	**m**. 16
b. P.C. = STA. 145 + 78.10	**h**. dist. btwn. PI and PT = 170.63′	**n**. S 1° 13′ 07″ W
c. P.I. = STA. 147 + 48.73	**i**. L = 338.77′	
d. Δ = 16° 56′18″ RT	**j**. N 17° 42′ 16″ E	
e. R = 1145.92′	**k**. N 0° 45′ 58″ E	
f. D = 5° 00′	**l**. 50′ + 50′ = 100′	

CHAPTER 4 – ANSWERS

4-1. No answer required

4-2.

a. Plan	**b**. Profile	**c**. Existing & proposed features of the project	**d**. Profile
e. Longitudinal Cross-Section	**f**. Title sheet	**g**. Centerline	**h**. left to right

4-3. No answer required

4-4.

a. 1″= 20′	**b**. 1″= 20′	**c**. 1″= 4′	**d.** double

4-5. **a**. False **b**. False

4-6.

a. 57+ 60, 42.80′	**b**. 57+ 80, 42.40′	**c**. 57+ 10, 42.40′	**d**. 57+ 90, 46.00′	e. 80′
f. 3.6′	**g**. 4.40′	**h**. 60′	**i**. 0.40′	

4-7.

a. 50′	**b**. 120′	**c**. 8′	**d**. 3′

4-8. No answer required

4-9.

a. proposed grade	**b**. Existing grade/ground	**c**. 46.00′	**d**. 43.20′
e. cut	**f**. proposed centerline, proposed grade		

4-10. No answer required

4-11. **a**. Vertical curves

4-12. No answer required

CHAPTER 4 – ANSWERS *(continued)*

4-13.

a. Plan	**b**. Profile	**c**. Circular	**d**. Parabolic

4-14. No answer required

4-15.

a. - 4.00%	**b**. + 2.25%	**c**. - 0.75%	**d**. + 34%	**e**. + 4.71%

4-16. No answer required

4-17. **a**. Vertical curve begins (Point of Curvature)

b. Vertical curve ends (Point of Tangency)

c. Point of Vertical Intersection

4-18. No answer required

4-19.

a. 46.32′	**b**. 46.31′	**c**. 46.27′	**d**. 46.10′

4-20.

a. sag	**b**. 42.86′	**c**. 135′	**d**. 157 + 10
e. 156 + 43	**f**. 157 + 77	**g**. + 0.90%	

4-21.

a. fill	**b**. cubic yards	**c**. 630 CU YDS	**d**. 20%
e. needing fill material from an outside source	**f**. yes	**g**. 1250 cubic yards *(embankment)* + 250 cubic yards *(20% compaction)* 1500 cubic yards *(total cubic yards of "fill" material reqd.)* - 630 cubic yards *(from cut - reused)* = 870 cubic yards of "borrow" material needed	

CHAPTER 4 – ANSWERS *(continued)*

4-22. No answer required

4-23.

a. Benchmark	**b**. Temporary Benchmark	**c**. Temporary Benchmark is a 60 penny spike driven into a 30″ diameter pine tree	**d**. BM is 29 feet to the right of Station 88 + 49
e. Louisiana Geodetic Survey	**f**. Louisiana Geodetic Survey and the Benchmark registration numbers	**g**. true	**h**. elevation and location

4-24. No answer required

4-25.

a. 4	**b**. railroad spike	**c**. 183′ RT of STA. 153 + 98	**d**. 46.89

4-26. No answer required

4-27.

a. 120 + 79.12	**b**. 114.05′	**c**. 123.84′	**d**. PC, centerline	**e.** at least 2

4-28. With regard to **P.I.**

a. 147 + 48.73 *(not 147+43.73 - plan typo)*	**b**. iron bolt	**c**. 4	**d**. 83.56′
e. 10d N/BC in 20″ sweet gum tree	**f**. 47.05	**g**. an “X”	

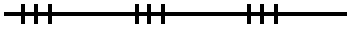
With regard to **P.T**.

a. 147 + 16.87 *(not 149+16.87 - plan typo*)	**b**. concrete nail and bottle cap	**c**. 3	**d**. 104.48′	**e**. 10d N/BC in PP/Trans

CHAPTER 4 – ANSWERS *(continued)*

4-29. With regard to Sheet 5 **a**. 106 + 67.89 **b**. NO

4-30. With regard to Sheet 6

a. 37.54′	**b**. finish grade	**c**. yes
d.	**e**. yes	**f**. 

4-31. **a**. 4

4-32. No answer required

4-33. **a**. 59 + 34, 59 + 82 or 62 + 10 (to be removed) **b**. 3 (to remain)

4-34. No answer required

4-35. **a**. 18″ **b**. 22′ **c**. corrugated metal pipe

4-36.

a. + 0.40%	**b**. 153 + 57.5	**c**. 154 + 25
d. 44.00′	**e**. 135′	**f**. 154 + 92.5
g. - 0.40%	**h**. crest	**i**. positive slope (rise) approaching VI, negative slope after VI.

4-37.

a. 170.63′	**b**. 147+ 43.73	**c**. 170.63′
d. N 17° 42′ 16″ E	**e**. 16° 56′ 18″ RT	**f**. N 0° 45′ 58″ E
g. 333.77′	**h**. 1145.92′	**i**. Fire Hydrant, 47.05′ 10d Guy Pole N/BC, 23.61′ 10d N/BC in 20″ Sweet Gum, 83.56′ 10d N/BC in PP, 42.99′

4-38. No answer required

4-39. No answer required

4-40. No answer required

4-41. **a**. 8″

4-42.

a. timber trestle	**b**. concrete slab span bridge	**c**. Dumplin Creek	**d**. 5
e. 47.70′	**f**. - - - - - - - - - - - - - - - - - -	**g**. 171 + 52.75	**h**. 40′

4-43. No answer required

CHAPTER 4 – ANSWERS *(continued)*

4-44. No answer required

4-45. No answer required

4-46. **a**. Exist. 46.73′, Fin. 43.72′ **b**. Exist. 46.32′, Fin. 43.10′

4-47.

a. 0.40%	**b**. 0.40%	**c**. crest
d. 154 + 92.5	**e**. 153 + 57.50	**f**. 154 + 25

4-48.

a. 161+83.32	**b**. 164+61.37	**c**. 167+16.65
d. N 17° 42′ 16″ E	**e**. 40° 00′00″	**f**. N 22° 17 ′44″ W
g. 278.05′	**h**. 278.05′	**i**. 533.33′
j. 763.94′		

4-49.

a. 54 + 81	**b**. 54 + 25	**c**. 55 + 92	**d**. 57 + 92

4-50. **a**. 3

4-51

a. 60 + 10 and 62 + 67.50	**b**. N 64° 27′ 35″ E	**c**. 45.80′	**d**. 4

4-52. **a**. 2-30″/36″ (EQUIV.) X 110′ CDPA **b**. RT= 32.20′ LT= 32.30′

4-53.

a. FALSE	**b**. TRUE	**c**. TRUE	**d**. FALSE

4-54.

Fence	_____ x _____ x _____ x_____
Water line	_____ W _____ W _____
Gas line	_____ G _____ G _____

CHAPTER 4 – ANSWERS *(continued)*

4-55.

a. combination pole	**b**. power pole	**c**. telephone pole
d. tree	**e**. underground telephone	**f**. gas line
g. pipeline	**h**. sewer line	**i**. water line

4-56.

a. 6 penny nail and bottle cap	**b**. temporary benchmark	**c**. right
d. point of vertical intersection	**e**. benchmark	**f**. flow line
g. point of tangency	**h**. water meter	**i**. reinforced concrete pipe arch

CHAPTER 5 – ANSWERS

5-1. **a**. Proposed **b**. Existing

5-2. No answer required

5-3. No answer required

5-4. No answer required

5-5. No answer required

5-6. No answer required

5-7.

a. arrow	**b**. 1st Cross Section drawing	**c**. bottom to top
d. corresponding station number	**e**. left side, minus	**f**. right side, positive
g. increase	**h**. 0 (zero), starting	**i**. centerline, right or left

5-8.

a. 110 + 09.96	**b**. 110 + 83	**c**. 111 + 00
d. 112 + 00	**e**. 112 + 17	**f**. 112 + 24

5-9. No answer required

5-10. No answer required

5-11.

a. 10 feet	**b**. across	**c**. elevation
d. 12 feet	**e**. 70 feet	**f**. 20 feet
g. 4 feet		

5-12. **a**. 41 feet **b**. 8 feet

5-13. No answer required

5-14.

a. 60′, 10′, right	**b**. 71′, 2′, right	**c**. 59′, 20′, left
d. 70′, 15′, left	**e**. 80′, 20′, right	**f**. 80′, 12′, left

CHAPTER 5 – ANSWERS *(continued)*

5-15.

a. centerline	**b**. original ground (existing grade)	**c**. 112 + 24
d. 37.51′	**e**. 6	**f**. 1′
g. 37.21	**h**. 36.00′	**i**. ROW
j. 65′	**k.** lower	

5-16. **a**. 324 **b**. 0

5-17. **a**. 33.90′ **b**. 33.00′ **c**. 34.00′

5-18.

a. 36.45′	**b**. 34.00′	**c**. 33.00′	**d**. 35.00′	**e.** 36.00′

5-19. **a**. 85′ **b**. 70′

5-20. **a**. 117 **b**. 178

5-21. **a**. 289 **b**. 301

5-22. **a**. 10′ **b**. 10′

CHAPTER 6 – ANSWERS

6-1.

a. F	**c**. F	**e**. F
b. F	**d**. T	**f**. F

6-2. No answer required

6-3. No answer required

6-4. No answer required

6-5. No answer required

6-6. No answer required

6-7.

a. 25.91′	**b**. 41.25′	**c**. 48.50′	**d**. 36.50′

6-8. No answer required

6-9.

a. 0.20′	**b**. 0.50′	**c**. 0.45′

6-10. 24.50′

6-11.

a. 0.048′	**b**. 0.060′	**c**. 0.10′

6-12. **a**. 240′ **b**. 30.408′

6-13.

a. 7.5′	**b**. 6.67′	**c**. 20.0′

6-14. **a**. 21.70′ **b**. 20.367′

6-15. 2.5′

6-16. No answer required

6-17.

a. Horizontal dashed line	**b**. Cross Section	**c**. Finished grade

CHAPTER 6 – ANSWERS *(continued)*

6-18.

a. 6″	**d**. ditch	**g**. 3:1	**j**. REQ'D R/W
b. Fill	**e**. Yes	**h**. 0.025 ′/₁	**k**. 1.5′
c. Cut	**f**. 4:1	**i**. 0.025 ′/₁	**l**. 4′

6-19.

a. between 37.36′ and 37.40′	**b**. between 35.85′ and 35.89′	**c**. approx. 30′	**d**. approx. 14′-15′

6-20. No answer required

6-21. **a**) base *course* **b**) surface *course*

6-22. No answer required

6-23. No answer required

6-24.

a. 82′	**c**. 82.5′ (82′-6″)	**e**. 7′	**g**. 6 inches
b. 0.05 ′/₁	**d**. 2″	**f**. 10′	

6-25.

a. 34.0′	**c**. 22.0′	**e**. 24.0′
b. 38.0′	**d**. transition	**f**. 200′

6-26.

a. Superelevated	**b**. Centerline to the highway edge	**c**. outside edge to the inside edge

6-27.

a. outside	**c**. inside	**e**. right	**g**. right
b. inside	**d**. left	**f**. left	

6-28. No answer required

6-29. No answer required

6-30. No answer required

6-31.

a. 2	**b**. 11′	**c**. 0 .22′

CHAPTER 6 – ANSWERS *(continued)*

6-32. **a)** 210′

6-33. **a)** to redesign the highway

6-34.

a. 240′	**b**. .100	**c**. 2.4′	**d**. 1.2′

6-35. No answer required

6-36. **Chapter 6 Review Question Answers**

a. fore-slope and R/W	**g**. 82.5′	**m**. 220′
b. 4′	**h**. 12″	**n**. 2.21′
c. 10′	**i**. NO	**o**. 220′
d. 2.5′	**j**. YES	**p**. .046
e. 4.0′	**k**. 0 .50′	
f. 82′	**l**. .092	

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